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LIVESTOCK IN ASIA

ISSUES AND POLICIES

EDITORS: JEFFREY C. FINE AND RALPH G. LATTIMORE

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Livestock in Asia:

Issues and Policies

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Résumé

Cette publication contient une version révisée de documents de travail présentés à la conférence de Singapour du 2 au 4 mars 1982. Cette conférence, qui avait pour thème l'élevage du bétail dans les pays asiatiques et les politiques suivies en la matière, avait également pour but d'attirer l'attention des administrateurs et des chercheurs de cette région du monde sur une série d'importants problèmes que leur réserve l'agriculture dans un proche avenir. L'objet général était donc de publier ce volume, qui dresse l'inventaire des recherches pertinentes et détermine les priorités des recherches futures. On s'est attaché particulièrement aux politiques qui mettent l'accent sur les aspects sociologiques et économiques. Cet ouvrage traite d'un certain nombre de sujets de recherche sur le bétail : production, marchés domestiques et internationaux, choix de politiques, méthodologie, etc. Il est possible de dégager la tendance des décisions que les administrateurs régionaux seront probablement amenés à prendre en matière d'agriculture.

Resumen

Esta publicación contiene una versión editada de las ponencias presentadas en una conferencia celebrada en Singapur del 2 al 4 marzo de 1982 sobre problemas y políticas relacionadas con la ganadería en Asia. El propósito de esta conferencia fue llamar la atención a los que toman decisiones y a los investigadores de la región hacia una serie de importantes problemas agrícolas con que se enfrentarán en el futuro. El objetivo general era producir este volumen que evalúa la investigación pertinente e identifica prioridades para la investigación futura. El foco principal se encuentra en la política que hace énfasis en los aspectos económicos y de ciencias sociales. Este volumen trata de varios puntos de investigación tales como producción ganadera, comercialización nacional e internacional, selecciones de políticas, y problemas de investigación ganadera. A su vez, éstas reflejan los tipos de decisiones que probablemente deberán tomar los gestores de políticas de la región.

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Preface

The complexity of the issues involved in the formulation of livestock policies first became apparent in discussions leading to support by the International Development Research Centre (IDRC) of research on a livestock sector strategy for Korea. Two facts quickly emerged: first, that the tradeoffs confronting that country's policymakers are likely to be encountered in other Asian countries and, second, that there has been relatively little research by Asian economists and other social scientists in this field.

Against this backdrop, the Social Sciences Division of IDRC encouraged the submission of papers by social scientists from within and outside the region. These papers were discussed at a conference held in Singapore from 2 to 4 March 1982. This monograph contains an edited version of these papers.

The IDRC is grateful to the Winrock Foundation, Agriculture Canada, and the World Bank for their assistance in financing the attendance of a number of participants who contributed stimulating papers and otherwise assisted in the preparation of this volume.

The success of the Singapore meeting was due, in large measure, to the enthusiasm and efficiency of the staff of the IDRC Asia Regional Office who did a superb job of arranging and running all of the conference facilities and services. Their efforts were capably reinforced by Division staff at the Ottawa end. I would like also to express my appreciation to the IDRC's Communications Division, and to Katherine Kealey-Vallière in particular, for editorial support in the preparation of this important monograph.

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Foreword

The development of agriculture in Asia has been associated mainly with increasing the production of cereals. This emphasis arises from the importance of cereals as part of people's diets and as a source of farmer income. Over the past 2 decades cereal production has increased in many Asian countries through major advances in seed varieties, farming techniques, farmer skills, improved fertilizer supply, and expanded irrigation. Many areas are no longer directly threatened by the spectre of widespread famine caused by a capricious nature.

Far less attention has been given to livestock production, although animals have formed an integral part of the Asian farm economy for thousands of years. Animals are prized for their draft power, manure, dairy products, and, to a much lesser extent, their meat. Animal husbandry has also been part of an intricate and rich pattern of customs and religious beliefs.

Economic development is accompanied by significant changes in consumption that affect the individual farming household. In the richer tier of Asian countries, rapidly rising incomes have prompted people to demand relatively greater amounts of meat and dairy products. Naturally, the specific type of product and the strength of this demand will vary across countries and cultures. The general trend, however, is evident in countries as different as Korea and Thailand. In the long term, the rapidly growing demand by Asian consumers for livestock products will affect the overall pattern of agricultural production. The reaction of policymakers to this challenge will profoundly affect the well-being of hundreds of millions of consumers and small-scale farmers.

To increase livestock production, Asians must overcome economic as well as technical constraints. Although livestock research has generally been neglected in favour of crop production, the livestock research that has taken place has thus far focused on technical issues. It includes such important matters as improved breeds, feed, and production methods. Relatively little research has been devoted to identifying the economic and social factors determining the ultimate success of the various projects, programs, and regulations that together make up government livestock policies.

This book contains the papers presented at a conference on livestock in Asia held in Singapore from 2 to 4 March 1982 and sponsored by the International Development Research Centre (IDRC). The main reason for sponsoring the conference has been to draw the attention of the region's policymakers and researchers to a series of important agricultural policy issues that they will be confronting in the years to come. The conference had two general aims. The first was to take stock of pertinent research. The second was to identify, through detailed discussion of individual papers, priorities for future research.

The policy focus of the conference is evident in the topics of the papers. It is also apparent in the very strong representation of social scientists, and of economists in particular, among the participants. The format of this volume, which is directly based on the conference agenda, addresses a number of research issues. These in turn reflect the types of decisions that the region's policymakers will probably have to make.

The first paper by De Boer provides an overview of the livestock sector in the region. It traces out the current pattern of livestock production and identifies the factors that will affect the farm economy in future. To what extent should governments rely primarily on small-scale farmers to expand livestock production? Will such farmers respond positively to higher prices for meat and dairy products? How will increased production of these products affect the supply of fertilizer and draft power, the output of cereal crops, and the availability of animal feed?

The paper by Jarvis provides an effective conceptual framework for generating hypotheses concerning the decisions likely to be made by traditional farmers. However, once one moves beyond the level of generalities, it quickly becomes apparent that there are many factors affecting farmer behaviour. The diversity and complexity of these factors, ranging from the degree of market access to the type of plow hauled by draft animals, are evident in the country studies by Kristanto, Sharma, Panayotou and Tokrisna, Ahsan, and Rendall and Lockwood. These papers by no means exhaust the richness of the subject. Rather they indicate the potential benefits to policymakers of further empirical research conducted within a rigorous conceptual framework.

Resource allocation at the farm level is directly influenced by other components of the food system. To what extent do marketing boards improve farmer welfare and successfully manage to reconcile the needs of producers and consumers? What alternatives are there for inducing more higher-quality production? Why does the production of certain livestock products succeed and others fail? How does one identify and measure changes in consumer tastes and use this information to project trends in demand? These issues and others are addressed in the series of papers concerned with various components of the livestock food chain. They include consumer tastes (Cho), prices and marketing policies (Girardot-Berg), processing and distribution (Nipon); the availability of feed supplies (Sukanto and Soedomo); and international market considerations (Lattimore). Neither the list of topics nor their treatment has by any means been exhausted.

Many Asian countries will have to decide whether or not to satisfy the growing demand for livestock products from domestic sources. For some countries, with limited land and a growing industrial sector, increased domestic livestock production can only be achieved by protecting farmers through tariffs and subsidies. The goal of self-sufficiency may be illusory because most of the feedgrain required to support increased livestock production would have to be imported. However, the application of the doctrine of comparative advantage must be set against other pressing demands. These include concerns over national security, uncertainties created by world livestock and feedgrain markets, the trauma of social and economic change at the farm level, the desire for a balanced and prosperous rural society, and so on. The papers contained in the section on national policy choices do not purport to address all of these issues. Rather they attempt to provide a national perspective as currently seen by Korean (Shim), Philippine (Mosqueda-Velasco), Thai (Tokrisna and Panayotou), and Indonesian (Soewardi and Atmadilaga) researchers and to identify, in a preliminary fashion, the type of research needed by national policymakers.

The papers in the final section on methodology anticipate some of the problems involved in conducting research. What are some of the major differences between the models used by natural and social scientists (Levine)? Can one apply to livestock the lessons learned from a generation of farming systems research on crops (Zandstra and King and Bernsten)? What are some of the practical difficulties involved in conducting farm-level research on livestock (Thomas, Mathius, and Sabrani)? How should research results be used in designing a program (Upadhyay)? Do the economist's large models have any relevance in the Asian context (Paddock)?

The papers sparked an exciting and at times heated discussion among the participants. They also stimulated interest in further research relating to livestock development. In publishing this volume, our goal is to encourage a similar sense of involvement by policymakers and researchers in the region.

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Overview

Livestock Development: the Asian Experience

A. John De Boer[1]

Abstract. The livestock industries of Asia represent a complex series of interactions between the environment, animals, humans, and levels of economic development. This paper focuses on current problems facing the Asian livestock industries, the nature of production systems used to produce livestock in Asia, and presents a general review of livestock projects and programs and a summary of lessons learned to date and how these lessons can be utilized to improve performance of the livestock sector in Asia.

Asian livestock production is characterized by low levels of productivity in the ruminant sector as well as in the traditional pig and poultry sectors. This can be explained by characteristics of the production systems, technology transfer, and demand patterns. The major possibilities for a widespread improvement in rural welfare centre around dairying in some countries and around improvements in the integrated crop–livestock system under which most cattle and buffalo are produced in Asia. These improvements will require long-term technical assistance and reorientation of traditional research, extension, and development approaches; appropriate changes in public policy; and smaller projects designed to achieve changes in existing crop–livestock systems.

Résumé. Les diverses industries du bétail, en Asie, sont soumises à des interactions complexes entre l'environnement, les populations, les genres d'animaux et le degré de développement économique. Cette communication s'attache aux problèmes d'actualité confrontant ces industries et à la nature des systèmes de production utilisés en Asie. Elle donne un aperçu des projets et programmes de développement des industries du bétail ainsi qu'un résumé des leçons recueillies jusqu'à présent, avec la manière dont ces dernières peuvent s'appliquer à l'amélioration du secteur des bestiaux dans cette partie du monde.

La production des bestiaux en Asie souffre du faible rendement du secteur des ruminants et des secteurs traditionnels du porc et de la volaille. La raison peut se situer dans les caractéristiques des méthodes de production, les transferts technologiques, et les tendances de la demande. Les plus grandes possibilités d'amélioration générale du bien-être rural se situent du côté des productions laitières dans certains pays et dans l'amélioration du régime mixte d'élevage et de culture sous lequel on produit, en Asie, la majeure partie des bestiaux et des buffles. La réalisation de ces progrès exigera une aide technique de longue durée, une réorientation de la recherche classique, des procédés de vulgarisation et de développement, des changements appropriés dans les politiques officielles, et des projets d'envergure plus modeste pour aboutir aux changements désirables dans les systèmes mixtes actuels d'élevage et de culture.

The objective of this paper is to stimulate thinking and discussion by Asians about their livestock industries and to seek ways and means by which animal agriculture can better serve sectoral and national development objectives. For this purpose a comparative approach is used. Comparisons are made among countries, animal species, and animal products in an attempt to synthesize some lessons learned from experience to date. The lessons learned can then be incorporated into national research, project planning, and project implementation to improve future performance.

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This approach begins with a general overview of a broad range of livestock programs including research, extension, infrastructure, production programs, and input support. Both public and private projects need consideration as well as domestic (as opposed to externally supported) programs. Rather than consider a few major projects in detail, this paper skims over a wide range of activities.

First, the problems faced by the livestock industries in Asia are discussed. Second, an overview of livestock production systems in Asia is set out. The trends, strengths, and weaknesses of each system, and policy options arising from them, are touched upon. Third, some livestock-oriented projects and programs are reviewed. Finally, the lessons learned

are synthesized and some criteria are listed for maximizing the potential contribution of animal agriculture to human welfare in Asia.

Problems Facing the Asian Livestock Sector

The livestock industries in developing countries received considerable attention and support during the 1970s in terms of research; financial assistance, both internal and external; private investments; and government programs. Within the Asian region, this focus was the result of several factors (De Boer 1976a). The first was a desire to move into activities with higher value added per unit of product marketed and into products with higher income elasticities of demand. Second, the initial promise of the Green Revolution opened up possibilities for increased supplies of grain by-products and possible diversification of marginal lands into feed grains, oilseed crops, and fodder crops for animal feeding. Third, livestock were seen as a means of increasing rural incomes, stabilizing incomes of small farmers, and increasing rural on-farm and off-farm employment. In many countries, fairly rapid rates of income growth and urbanization resulted in a rising demand for livestock products. If this demand could not be met by domestic supplies, undesirable inflationary or foreign exchange consequences would result. Also, livestock products were seen as a means of improving protein supplies and protein quality to vulnerable groups of the population. Several publications were issued and international conferences held to (a) examine the role of animals in meeting world food needs (Rockefeller Foundation 1975; Winrock 1978), (b) examine the contribution of livestock on small farms (Johnston 1975; APO 1976; FAO 1976; McDowell and Hildebrand 1980), and (c) assess the potential for livestock in farm diversification (APO 1976). Despite these efforts, the gradual transformation of the agricultural sector from one largely dependent on cereal products to one generating a large share of total output from livestock has been very slow or nonexistent in most Asian countries.

Only where economic transformation has been rapid and sustained over a considerable period of time has the contribution of livestock to agricultural gross domestic product (GDP) increased substantially. In Korea, the contribution of livestock to GDP in agriculture went from 5.4% in 1961 to 15.4% in 1973 (APO 1976). Chang (1981) notes that the share of livestock in total agricultural production in Taiwan went from 18% in the 1952–56 period to 29.5% by 1977–79. The share of crops declined from 66.5 to 47.6%. The contribution by fisheries also more than doubled.

These patterns clearly indicate that growth in demand for livestock products is heavily dependent on economic growth (Weber and Gregersen 1977). Most Asian countries are in a deficit situation regarding per-capita consumption of livestock products as based on minimum dietary requirements. This situation results from the circular pattern of low levels of animal product supplies caused by low returns on resources devoted to animal production, which is caused, in turn, by low levels of purchasing power of the vast majority of the population. Livestock projects and programs must seek ways and means to alter this relationship between animal protein consumption and income levels. In retrospect, the high expectations that livestock would contribute substantially to agricultural sector goals have not, by and large, been met.

The Demand–Supply Situation

In general, the developing countries of Asia have been unable to close the demand–supply imbalances for livestock products. The most recent figures on ruminant livestock populations from the Food and Agriculture Organization of the United Nations (FAO) Production Yearbook show virtually no growth in livestock populations for most Asian countries. Table 1 gives annual percentage changes over the 1970–79 period for cattle, sheep, goats, swine and water buffalo. These figures indicate that population growth of the two major species in terms of animal units, cattle and water buffalo, was virtually stagnant, whereas swine numbers showed moderate to strong growth. Given the continued low productivity per animal, the supply of livestock products reflects a sharp contrast to the projected increases in food demand over the 1970–80 period (Table 2). As a consequence, increases in imports of animal products have jumped sharply (Table 3).

A number of attempts have been made to assess the long-term demand, supply, and trade situation in Asia (APO 1976; Winrock 1978; Wheeler et al. 1981). The most recent estimates are by Simpson (1981) who uses an adjusted trend analysis. These estimates are presented in Table 2. In general, these figures are fairly realistic on the supply side where rapid growth is not anticipated. The demand projections indicate that, in most cases, per-capita consumption of beef, veal, and water buffalo will remain level or decline. Consequently, any increase in consumption of animal protein will come from dairy products; sheep, goat, or nonruminant meat sources; and imports.

Table 1. Cattle, sheep, goat, swine and buffalo populations ('000) in 1979 and average annual percentage change, 1970–79.

Region	Cattle		Sheep		Goats		Swine		Buffalo	
	Number of head	% annual change	Number of head	% annual change	Number of head	% annual change	Number of head	% annual change	Number of head	% annual change
Industralized										
North America	123192	−0.1	12654	−4.4	1386	−5.3	68126	0.0	0	0.0
Western Europe	95064	0.6	87469	0.4	9842	0.1	109253	2.6	86	3.0
USSR, east Europe	153558	1.9	186733	0.5	7242	−1.1	136283	3.8	733	−0.7
Oceania	36203	1.6	197264	−1.8	148	−2.1	2770	−0.8	1	11.1
Others[a]	17600	2.0	31711	−1.3	5510	−0.8	11084	4.9	0	0.0
Total	425617	0.9	515832	−0.8	24128	−1.0	327516	2.4	820	−0.4
Less industrialized										
Middle and South America	267304	2.3	116585	−0.7	29053	−0.2	74369	2.1	318	17.0
Central and Southern Africa	148882	1.3	105235	1.4	126657	1.2	7564	3.9	0	0.0
North Africa and the Near East	35854	1.9	140772	1.3	62250	0.1	312	5.8	3790	−0.3
South Asia	241242	0.6	91671	1.7	115766	2.0	10454	6.0	14723	−0.4
Centrally planned Far East	68985	0.2	109891	2.3	77333	1.7	316941	2.6	32421	0.2
Open economies Far East	24125	0.2	3969	1.5	10734	2.0	24520	1.1	78485	1.3
Others[b]							1783	3.6	0	0.0
Total	786392	1.3	568123	1.1	421793	1.3	435945	2.5	129737	0.8
World Total	1212009	1.2	1083954	0.1	445919	1.1	763461	2.5	130557	0.8

[a]South Africa, Japan, and Israel.
[b]Oceania other than Australia and New Zealand.
Source: FAO Production Yearbook, 1979.

Table 2. Summary of projections of Asian total production, consumption, and trade (10^3 t) of beef, veal, and buffalo meat, 1985–90.

Country	1985			1990		
	Total production	Total consumption	Net trade	Total production	Total consumption	Net trade
Japan	461	637	−176	534	757	−223
Republic of Korea	127	206	−79	157	284	−127
Bangladesh	197	196	1	223	237	14
Malaysia	17	32	−15	18	40	−22
Philippines	181	219	−38	207	266	−59
Sri Lanka	20	20	0	22	22	0
Vietnam	94	93	1	95	92	3
China	2448	2433	15	2628	2578	50
Burma	105	107	−2	114	116	−2
Indonesia	189	176	13	196	177	19
Pakistan	376	370	6	404	396	8
Thailand	269	283	−14	309	347	−38

Source: Simpson (1981, pp. 46–48).

Table 3. Increases in imports of meat and meat animals plus all forms of milk products by developing countries, 1975–79.

Continent[a]	Value of imports in 1979 (10^6)	Increases in imports from 1975–79 (%)
Meat and meat animals		
Africa	843	+242.20
South America	553	+ 91.30
Asia	3578	+ 46.90
Milk in all forms		
Africa	677	+102.07
South America	204	+ 63.20
Asia	1035	+ 97.10

[a]Africa, 40 countries; South America, 13; Asia (except China), 38.

Source: FAO Trade Handbook, 1980.

Productivity Problems

The outstanding feature of cattle and water buffalo production in Asia is the low offtake per unit. Table 4 gives figures for 1979 by species and region. The figures for large ruminants are heavily influenced by data from India. Overall, Asia has 37% of the world's total combined population of cattle and water buffalo, but produces only about 10% of the world's cattle and buffalo meat (Johnston 1975). Excluding the Indian cattle population from the total puts the combined Asian population of cattle and water buffalo at 20% of the world's total so meat offtake per unit is still about 50% of the world average. The same general pattern holds for sheep and goats. Although the figures for the Far East (Table 4) are quite high by developing country standards, the 46% of the world's small ruminant population held in Asia produces only 29% of the total world supply of sheep and goat meat. Figures given in a recent publication (Winrock 1978) substantiate these estimates. For nonruminants, an important distinction needs to be made between the modern and traditional sectors because a dualistic production structure is evident (De Boer and Weisblat 1978). The modern sector has productivity levels almost comparable to developed-country standards, whereas the traditional village subsistence production structure achieves productivity levels far below that of the modern sector (APO 1976). An excellent summary of recent estimates of efficiency measures for various types of livestock was prepared by Pino and Martinez (1981) from a variety of sources. Their estimates are indicative of the tremendous productivity gap that exists not only between the current levels in developing countries as compared to the ceiling levels but even between modern, state of the art production units in developed countries and the ceiling levels.

One reason for the low offtake figures for cattle is their widespread use for draft power. This results in large numbers of buffalo and oxen held until an advanced age, lower productivity from females used for work, and offtakes approximating that of herds where no culling is practiced (about 10%). However, this sacrifice in output must be balanced against the major contribution made by draft animals. On a worldwide basis, draft animals total between 280 and 300 million head with a market value of U.S. $100 billion. They provide the equivalent in power

Table 4. Percentage of animals slaughtered, 1979.

Animals	Africa	Latin America and the Caribbean	Near East	Far East	Other developing countries
Cattle	11	16	16	3	15
Buffalo	—	0	29	6	—
Sheep	29	17	35	37	52
Goats	32	28	33	45	29
Pigs	76	47	99	81	56

Source: FAO Production Yearbook, 1979.

of 1.36×10^{12} kW, the replacement of which would cost nearly U.S.$250 billion using mechanical sources (Ramaswamy 1981). In the Asian region, the major role played by draft animals seems likely to persist. As part of its "Agriculture 2000" project, FAO has estimated agricultural input requirements needed to meet specific rates of increase in crop production. The FAO estimates point to an increased share of power being supplied by mechanical means, but a large total increase in draft animal numbers is still indicated (Table 5). Overall, draft animal inputs are calculated to rise by 0.8%/year. In Asia, such an increase will be very difficult to maintain for the following reasons: (a) substantial slaughtering of draft animals and replacements have already occurred in parts of Asia in response to demand for red meat far outstripping local supply capacity, and (b) the severe overgrazing of India's grasslands has led to ecological damage that has limited India's ability to substantially expand the stock of productive bullocks without elimination of substantial numbers of cows.

Animal Research: Problems of Capacity and Implementation

The cost of conducting animal research is high, and, in general, the application of the results from such research is slow. A recent survey in the U.S. carried out by the Cooperative State Research Service calculated the relative costs per scientist-year (SY) of various disciplines between plant, animal, human, and other areas of science. Table 6 gives these results for 1977 and indicates the high cost of animal-related research in the U.S. There is no reason to suspect that these relative costs would be greatly different in developing countries. On the other hand, the economic benefits from research and extension programs devoted to livestock are often slow to be realized, particularly for large ruminants with long intervals between generations. In addition, most livestock in Asia are held by small-scale farmers with limited land and capital resources to reallocate to livestock. Livestock are often a small proportion of total farm assets and total farm output. They are usually kept for several purposes (De Boer 1976c); therefore, rapid adoption of research results is seldom achieved.

Another problem is that much of the research does not take sufficient account of the resource structure and farmers' objectives relevant to the small, mixed-farm systems upon which most livestock in Asia are held (Areekul 1980). One research approach that has been developed to overcome this and related problems is farming systems research (FSR). Philosophically, there is much to recommend this approach both in terms of designing research programs as well as in achieving more rapid adoption of technology.

Table 5. Estimated numbers (in millions of units) of draft animals and tractors, 1980–2000.

Region	1980		1990		2000	
	Draft animals	Tractors	Draft animals	Tractors	Draft animals	Tractors
90 developing countries	165	2.6	175	5.8	185	14.2
Africa	14	0.2	16	0.5	17	1.3
Far East	126	0.6	135	1.6	145	4.9
Latin America	17	1.3	17	2.9	16	6.2
Near East	7	0.5	7	0.9	6	1.8
Low-income countries	130	0.5	140	1.3	150	4.4

Source: Ramaswamy (1981, p. 27).

Table 6. Relative cost[a] of scientist-year by various disciplines.

	Animal	Human	Other
Biochemist	125	153	129
Biologist	146	103	101
Biologist (molecular)	166	—	186
Entomologist	93	109	100
Geneticist	186	113	113
Immunologist	190	138	182
Microbiologist	110	121	116
Nematologist	102	—	126
Nutritionist	152	89	—
Pathologist	126	147	118
Physiologist	153	—	151
Virologist	115	62	100

[a]Basis: Cost of plant scientist-year = 100.

Source: United States Department of Agriculture (USDA), Cooperative State Research Service Survey, 1977.

There are also a number of useful summaries of recent research on animal production in Asia (APO 1976; Trinidad and Bandong 1976; Kim and Sul 1977; Madamba 1981; NRC 1981; Tillman 1981) and some requirements for making the research more relevant for the Asian farmer (Johnston 1975; Scoville 1976; Chantalakhana and Na Phuket 1979; Areekul 1980; Fitzhugh and De Boer 1981; Ramaswamy 1981; Winrock 1981; Bernsten, this volume).

Feed Resource Problems

The general consensus among researchers, development specialists, and farmers is that feed resource limitations are the most pervasive constraints limiting animal numbers and productivity (Winrock 1978; Fitzhugh and De Boer 1981; Thangarajah 1981; Wheeler et al. 1981;). Assessment of feed resources is particularly difficult because it must be considered at national, regional, and farm levels. Participation in international trade can quickly expand or contract the concentrate component of the feed base. Feed quality of roughages available in the monsoonal tropics shows marked seasonal variation. There are also many nonconventional feeds and data on such feedstuffs are generally not reported. Finally, on-farm feeding of crop by-products is difficult to account for.

The conventional, project-oriented response has been to develop ranches based on the Western model, to introduce pasture rotations into the traditional crop-fallow system practiced throughout monsoonal Asia, or to introduce concentrate feeds for strategic seasonal supplementation (Fitzhugh and De Boer 1981). The relative lack of success with these approaches has led to schemes to increase the productivity of public grazing lands at low cost (Wickham et al. 1977), to low-cost methods of supplementation based on locally available energy sources (Hall and De Boer 1977), and to efforts to improve the feeding quality of locally available crop by-products and residues (APO 1976; Fitzhugh and De Boer 1981; NRC 1981; Tillman 1981).

The most rapid expansion of animal production has occurred in the pig and poultry sectors of those Asian countries experiencing rapid economic growth. In many cases, this trend has led to sharply increased imports of coarse grains and oilseed meals. The current situation in Asia is summarized in a recently completed study (Wheeler et al. 1981) that examined the world animal feedstuff situation. The actual and projected breakdown of grain use in Asia is shown in Table 7, and Table 8 gives changes in Asian coarse grain trade from 1967 to 1968 through 1978 to 1979. Aside from India, the region is characterized by a group (listed as other South Asia) that has little net trade, a traditional exporter (Thailand), an occasional exporter (Indonesia), and rapidly growing import markets (high- and low-income East Asia).

An Overview of Traditional Livestock Production

The valuation of inputs and outputs within the livestock production system is the critical factor in designing a consistent set of livestock policy choices and in formulating projects that will have the desired outcome. Crotty (1980) provides numerous examples of cattle development schemes that have not achieved the desired effects because the impact of these valuation problems was not fully accounted for. Therefore, the first step must be to identify the critical elements of the production system. Because the vast majority of Asian livestock are produced under mixed crop–livestock farming situations (Humphries 1980; Winrock 1981), this will involve a strong component on crop–livestock interactions. Once this is done, the specific enterprise options can be considered. A good example for dairying is provided by Wilkens et al. (1979) and for a mixed dairy–beef system by Wu (1978).

Ruminant and Nonruminant Production

Another approach focuses on the distinction between ruminants and nonruminants in the traditional and modern sectors (De Boer 1976a). Prior to the 1950s, most Asian livestock were produced under a scavenger system for subsistence consumption.

Table 7. Asian world grain production and use, 1977–78 and 1985 projected (10^6 t).

Region	Grain production and use						Major grain uses							
	Surplus (deficit)		Production		Use		Livestock feed		Human and industrial		Seed		Waste	
	1977–78	1985	1977–78	1985	1977–78	1985	1977–78	1985	1977–78	1985	1977–78	1985	1977–78	1985
India	(0.3)	4.2	58.2	80.9	58.5	76.7	2.0	2.2	54.0	71.3	2.4	3.1	0.1	0.1
Other S. Asia[a]	(2.9)	(5.5)	16.1	19.6	19.0	25.1	0.2	0.2	18.2	24.0	0.6	0.9	0.0	0.0
Thailand	1.6	2.0	2.6	4.2	1.0	2.2	0.8	1.7	0.2	0.5	0.0	0.0	0.0	0.0
Other S.E. Asia[b]	(0.8)	(1.3)	0.4	0.4	1.2	1.7	0.3	0.5	0.9	1.2	0.0	0.0	0.0	0.0
Indonesia	(1.1)	(5.0)	2.8	2.9	3.9	7.9	0.5	0.7	3.4	7.2	0.0	0.0	0.0	0.0
High income E. Asia[c]	(4.4)	(8.4)	1.5	2.4	5.9	10.8	2.0	5.5	3.8	5.3	0.0	0.0	0.1	0.1
Low income E. Asia[d]	(1.8)	(2.2)	2.9	4.0	4.7	6.2	1.7	2.1	2.8	3.9	0.1	0.1	0.1	0.1
Total, Asia	(9.7)	(16.2)	84.5	114.4	94.2	130.6	7.5	12.9	83.3	113.4	3.1	4.1	0.3	0.3

[a]Afghanistan, Bangladesh, Bhutan, Nepal, Pakistan, and Sri Lanka.
[b]Burma, Cambodia, Laos, and North and South Vietnam.
[c]Hong Kong, Singapore, South Korea, and Brunei.
[d]Malaysia and the Philippines.
Source: Wheeler et al. (1981, p. 73).

Table 8. Asian net imports and exports of coarse grains by region, 1967–68 to 1978–79 (10^6 t).

Region	1967–68	1968–69	1969–70	1970–71	1971–72	1972–73	1973–74	1974–75	1975–76	1976–77	1977–78	1978–79
India	−1314	−56	−314	−15	0	−836	−828	−286	−670	34	3	0
Other S. Asia[a]	−298	−2	0	8	10	−4	−7	−17	3	−17	−17	−17
Thailand	1308	1343	1559	1743	2242	1136	2319	2186	2556	2309	1317	2230
Other S.E. Asia[b]	90	40	−67	6	13	0	−15	−15	−55	−60	−150	−150
Indonesia	108	110	202	246	155	−11	145	228	51	−65	−7	−5
High income E. Asia[c]	−320	−461	−378	−534	−839	−1413	−1146	−1464	−1723	−1935	−2632	−2510
Low income E. Asia[d]	−32	−80	−124	−173	−363	−370	−319	−396	−399	−475	−460	−426
Total, Asia	−458	894	878	1281	1218	−1498	149	236	237	209	−1946	−878

[a]Afghanistan, Bangladesh, Bhutan, Nepal, Pakistan, and Sri Lanka.
[b]Burma, Cambodia, Laos, and North and South Vietnam.
[c]Hong Kong, Singapore, South Korea, and Brunei.
[d]Malaysia and the Philippines.
Source: Wheeler et al. (1981, p. 29).

Because so few inputs were purchased outside the farm, the farmers' supply of animal products depended heavily upon individual and communal land resources. In the absence of technical advances in the herding of animals, continued expansion of animal product supplies would eventually have come up against a land constraint.

The ruminant and nonruminant production systems then began to diverge. Nonruminant production was more influenced by modern production technologies. This trend was accelerated by two factors: the dramatic increases in productivity achieved in pig and poultry production because of relatively straightforward technology transfers from temperate regions and a gradual expansion of international trade in feedstuffs, including P.L. 480 commodities. These two factors encouraged the rapid growth of swine and poultry industries utilizing predominantly industrialized forms of production clustered around major urban markets, which were often points of entry for imported feedstuffs. These developments caused a gradual reduction in the importance of land resources as a limiting factor governing output of pork, poultry meat, and eggs. Supplies of these products became more dependent upon the availability of foreign exchange to finance feedstuff imports and the growth of domestic markets to absorb the increased output.

The ruminant animal industries in Asia experienced no comparable increases in productivity or in easily accessible feed supplies and, thus, continued to depend heavily upon domestic land resources as the major input. This sector retained its location-specific character because large quantities of low-cost roughages were needed that could only be supplied economically from local resources. The swine and poultry industries, by contrast, are not as location-specific because they are less dependent on local land resources. Because the animal feedstuffs used in the expanding modern sector of these industries are traded internationally and exhibit fairly uniform prices within Asia, and because the productivity levels within these industries are converging, we would expect much more uniform production costs and prices to prevail within the region for pig and poultry products. Beef represents the ruminant sector, and eggs represent the nonruminant sector in Table 9, which gives the price spread during 1970 for several Asian countries. Singapore, with essentially free trade, represents the median point. Countries such as Thailand and the Philippines, with relatively abundant roughage supplies, have much lower beef prices, whereas the deviation of egg prices is much less dramatic due to factors cited above.

Table 9. Beef and egg prices in selected Asian countries in 1970 (U.S.$).

	Beef		Eggs	
Country	Cost ($/kg)[a]	% deviation from mean	Cost ($/dozen)[b]	% deviation from mean
Japan	2.36	+80	0.70	+28
Korea	2.08	+58	0.47	−14
Singapore	1.31	0	0.55	0
Taiwan	1.09	−17	0.48	−12
Philippines	0.57	−57	0.68	+24
Thailand	0.47	−64	0.40	−27

[a]Wholesale prices.
[b]Retail prices.
Source: De Boer (1976a).

Technical Efficiency

The most direct way to compare systems is with efficiency parameters such as birth, death, and growth rates; mature animal size; lactation yields; or dressing percentages. A traditional livestock production system is one in which animal efficiency levels are consistently lower than those in the modern sector and have remained relatively unchanged for a long period.

Scale of Operation

Traditional systems are normally small scale in terms of number of animals and capital invested in the livestock enterprise, although traditional grazing systems in extensive areas may include fairly large herds. The number of animals supporting the family is seldom much in excess of subsistence requirements. The major drawback of small-scale operations is the inability of individual producers to use profitably the specialized livestock production resources, which are the source of high productivity in the larger-scale modern sector.

Reliance on Purchased Inputs

Because the small-scale traditional producer lacks specialized production resources, it follows that the proportion of purchased inputs to noncash costs will be much lower in traditional systems that, in many cases, approach a pure subsistence level on the input side. This low proportion of purchased inputs also implies that the avenues for technological change entering through the purchased input avenue are very limited. Modern systems rely on much higher proportions of purchased inputs, particularly so with respect to nonruminant production where close to 100% of the inputs may be purchased.

Price Response

The higher proportion of direct costs in the modern sector implies that output responds more sharply and quickly to external economic forces than in the traditional system. The decline in Asian commercial poultry populations during 1972–74 illustrates the response to higher feed prices during this period. Traditional production systems have fewer cash costs, or none at all, and the production inputs, thus, receive only imputed returns, which are realized only at the time of sale or consumption of the product. The importance of imputed inputs in traditional systems makes economic analysis for predictive or policy purposes very difficult. Input price fluctuations are transmitted to the traditional producer through the opportunity cost of these inputs used in small-scale livestock production. For tradable products, such as rice bran, a rise in world feed grain prices is transmitted back to the traditional producer as the price of rice bran (a close substitute for coarse grains in animal feeds) rises. Farmers must then evaluate their gains in feeding the rice bran to their pigs or chickens or selling it. For a commercial producer with fixed costs in land, buildings, and salaried staff, the decision is not as straightforward because the choices open to the producer are fewer.

Proportion of Output Sold

The traditional system sells a low or negligible proportion of output. Examples include traditional dairying in South Asia, scavenger pigs or chickens in villages, and small sheep and goat herds, which produce meat and sometimes milk (Devendra 1981a) in small quantities. Draft animals, although usually produced by traditional methods, normally are too large an output to be consumed by the producing unit so they are usually sold and the receipts used for animal replacement. Modern production is oriented toward cash sales. Reliance on the market for outputs makes commercial producers much more subject to external forces over which they have no control.

Labour Use

Traditional systems use unpaid family labour, and owner–operator decisions dominate. Labour per unit of output tends to be much higher than in the modern sector. The opportunity cost of labour for livestock production varies according to demands made by the cropping system. Certain livestock enterprises are arranged so as to utilize the low opportunity cost of family labour during the off-season. Modern production systems tend to directly employ labour and management. The lower input of labour per unit of output in the modern sector arises because the market wage rates that must be paid exceed the opportunity cost of traditional producers and their family labour, and the other production inputs in the modern sector tend to be labour saving in nature.

Feed Supplies

In the traditional sector, feed is generally home produced and the proportion of purchased feed, if any, is small. Ruminants fed under low-cost traditional systems tend to be located near abundant roughage, whereas nonruminants tend to be located near the household. In both cases, feed supplies are closely tied to the local cropping system, which dictates the volume and quality of roughage and concentrate by-products available during the year and the pattern of grazing and herding. The transition to a modern system involves a gradual spatial separation between the production and utilization of feedstuffs. Product market considerations gain more importance as to where animals are produced, whereas feedstuffs are now sold to livestock producers. This trend is particularly evident for poultry and pigs, whereas dairying typifies this trend in the ruminant animal sector.

Product Marketing

Traditional producers, because of their small-scale operations, market few animals and sell on an intermittent basis, if at all. Small-scale intermediaries handle the transport and assembly functions needed to make up economical numbers of animals for shipment to larger markets. The increasing availability of improved transport facilities, large-scale transport modules, and centralized marketing facilities has tended to favour the larger, modern-sector producers who can make frequent large shipments. Production can be more closely oriented toward specific markets. Vertically integrated production for specific markets or specific user's requirements becomes possible because quality and timeliness for production are better controlled in modern systems.

An Overview of Some Livestock Programs and Projects

Dairying

Dairying in Korea

Korea has made a conscious policy choice to develop the dairy sector to meet the anticipated demand for dairy products caused by a rapidly developing economy (Kim and Sul 1977). The choice was based upon a widespread use of dairy products; a well developed transport system to get the raw product to

the processing centres and the final product to retail outlets; favourable environmental conditions for dairy cattle; a progressive, hard-working farmer population; and substantial research capacity in the animal science area. Over the 1961-74 period, average per-capita consumption of milk increased from 0.05 to 4.0 kg and by 1978 had reached 8.8 kg. During the 1960s, a dairy industry development plan was formulated. The favourable climate has allowed direct importation of Holstein–Friesian cows. A total of about 25 000 head was imported from 1961 to 1974. Average production per cow increased from 3200 kg in 1961 to 4600 kg in 1971 and has increased further since then. Much of the growth has been made possible by increased imports of concentrate feeds, which stood at 39% of the total dairy feed requirements in 1978 (Kim, undated). This has meant that the major input cost, feed, has been priced at international market prices, which has made milk somewhat of a luxury good based on Korean income levels. Kim (undated) reports that milk consumption by the lowest income group is 31.5% that of the average level, whereas the highest income group consumed 69.8% more than the average. Prices of imported dairy products bear no relationship to domestic resource costs (De Boer 1981). According to Kim (undated) locally produced nonfat dry milk cost Won 2450/kg (as of 1982, Won 700 = U.S. $1.00), whereas the price of the imported product was Won 1311/kg. Domestically produced butter and cheese were, respectively, 46% and 170% higher than import prices. Another reason for high domestic costs is that small-scale dairy farms are located near large cities where demand is high but supply is limited.

Current development strategy calls for relocating dairying to marginal areas of hilly land that are suitable for pasture production. Imported stock is being distributed to farmers in rural, hilly areas and pasture development costs are being subsidized. On larger farms, 30% of the cost is government subsidized, whereas on smaller farms, 68% is subsidized. Another 14% of the cost is met through government loans. Partial support came from an International Development Association (IDA) loan in 1971, and the World Bank has also helped import dairy animals and establish three additional processing factories.

Overall, dairying in Korea has been a success in terms of production and consumption figures. It is, perhaps, too much to expect dairying to help solve the nutritional problems of low-income groups, but milk does remain the cheapest and most complete source of animal protein. Eventually, fresh fluid milk will most likely be provided exclusively by the domestic industry, but imports of some manufactured products will fill market gaps that the local industry cannot satisfy economically.

Dairying in Thailand and the Philippines

The development of a viable dairy industry continues to elude Thailand and the Philippines. In the hot, humid tropics, dairy development has been stifled by a combination of yield-reducing environmental stresses, difficulties in establishing and maintaining productive mixed grass–legume pastures, high enterprise establishment costs, limited size of market, product perishability, lack of regular consumption of dairy products, and a market dominated by low-cost imports. The industry is concentrated in a few localities where there have been long-term foreign-assistance programs. In conjunction with these programs, farmers have been provided a variety of subsidized inputs and other forms of assistance. Even so, loan repayments have often fallen behind or been neglected.

Dairying in India

In general, the type of livestock held by Indian farmers is a function of their draft power needs. If possible, farmers want a pair of bullocks and a cow for production of bullock replacements and a little milk (Brumby 1981). Current figures show that there are about 74 million bullocks, 48 million cows, and 26 million buffalo cows. The latter produce 55% of the national output of milk. By Asian standards, milk consumption in India is quite high with a national annual average per-capita consumption of 44 kg and urban consumption of more than 73 kg/capita/year. Urban demand is growing at over 5%/year and the real price of milk is increasing faster than the general price level.

Performance of the dairy industry over the past 15 years has been considerable, due in part to the National Dairy Development Program. There are several key elements of this program that have been suggested for other countries in Asia and elsewhere. The proceeds from sales of imported nonfat dry milk powder and butter oil have been used to help finance much of the local currency component of dairy development programs. Limited assistance has been provided by the IDA, the International Bank for Reconstruction and Development (IBRD), and a number of bilateral programs that have assisted in artificial insemination, crossbreeding, and dairy technology. A model has been developed called the Anand pattern of dairy development. Key elements of the program include formation of Dairy Cooperative Societies (DCS) composed of local milk producers. The Societies purchase milk for cash on a commission basis. All DCS are members of collective milk unions that own the factories. The unions provide the needed technical inputs to the Societies. The unions have now created federations that employ specialists in processing, marketing, financing, and investment programs. This model is a mixture

of a capital-intensive, processing-distribution system and relatively simple, low-cost farmer assistance with organizational and technical inputs.

Dairy development in India has had a substantial employment-creating effect. Brumby (1981) notes that, based on World Bank estimates, a project that produces and markets 100 000 L/day creates additional employment of 10 000 jobs at a cost of about U.S.$500 per job created. Direct staffing posts add an additional 2000 jobs. Linkage effects are often substantial. Backward linkage is produced through feed supplies and forward linkages through the assembly, transport, processing, and distribution activities for dairy products. Linkage effects caused by the establishment of a milk processing plant were recently studied by Chawla et al. (1979). Backward linkage effects were proportional to farm size. Revenue generated in backward linkages for each dollar of milk purchased by the plant were (smallest to largest farm size groupings, respectively) 0.51, 0.136, 0.139, 0.532, and 1.327. Dairying can also have a substantial impact on agricultural production. The Indian experience indicates that the infusion of cash from commercial dairying is often spent on other agricultural inputs. Brumby (1981) notes that 50% of incremental income from dairying is spent on fertilizer, seeds, irrigation, water, and animal feeds. Increased supplies of manure are also important.

The Indian case illustrates how major changes in livestock production can serve as a catalyst for positive change in traditional agriculture. Aside from the aspects mentioned above, the democratic structure of the DCS has led to a breakdown of certain caste structures thought to inhibit development. The distribution of crossbred cattle has also led to fundamental changes in farmers attitudes toward surplus stock and land use patterns, which have also inhibited development. Finally, rural welfare has been improved with minimal government involvement and with minimal commitment of scarce financial and administrative resources.

Dairying in Sri Lanka

Pillai (1976) reports on some aspects of the Sri Lanka IDA Dairy Development Project. Part of the project concentrated on replacing uneconomic plantings of tea with high-yielding tropical grasses. This allowed up to four cows/ha to be carried and resulted in farm incomes of from five to ten times that realized from tea.

Thangarajah (1981) presents some current figures on the status of dairying in Sri Lanka. The level of per-capita milk consumption is 40% of estimated nutritional requirements. Annual consumption per capita averages 16.8 kg of which 49% is locally produced and 51% is imported. From 1938 to 1979, four distinct dairy development plans were formulated and executed. All plans relied heavily on the public sector through networks of state farms that served as production units, training centres, and stock multiplication. Minimal assistance was offered to the private sector in general and to the small farmer in particular. Price controls and the operation of government procurement through the National Milk Board also discouraged private consumption. Between 1962 and 1973, cattle and water buffalo numbers dropped by 27.5 and 36.9%, respectively (Thangarajah 1981, p. 339). Present levels of milk production are 36% less than in 1972. Some current programs aimed at reversing these trends are a Swedish International Development Authority (SIDA) artificial insemination program, calf-rearing units set up by the National Livestock Development Boards to reduce calf losses, and an expansion of the milk-collection network (Pillai 1976).

Beef Production in Southeast Asia

The options that have been tried in beef production in Southeast Asia include commercial ranching on land development schemes, smallholder beef production on resettlement tracts, feedlotting, communal pasture development, and forage production on a crop rotation basis.

Commercial Ranching

Several private and quasi-private commercial ranching schemes have been attempted in Northeast Thailand, Mindanao Island in the Philippines, and the Eastern Islands of Indonesia. In addition, commercial coconut plantations have also developed joint beef enterprises. In general, financial success of these projects was predicated upon being able to purchase surplus stock from surrounding smallholders at low prices, improve the genetic base through crossbreeding, realize a premium price for ranch-produced beef, and achieve substantially higher levels of productivity than local smallholders. Also, direct or indirect input subsidies were often involved. The schemes in Indonesia have not been very successful, partly because planned output per unit was far too optimistic. The Malaysian scheme, MAJUTERNAK, the state-owned livestock corporation, is analyzed in detail by Crotty (1980, pp. 157–161). The ranching schemes are designed to produce heifers for sale to Malay smallholders. However, under smallholder economic conditions, they have found it much more profitable to sell the heifers for meat than to keep them as a producing unit. The Northeast Thai ranching schemes have been conducted largely by the private sector and have not been financially viable because no premium market for good-quality beef exists and the fertilizer–animal price ratio is very unfavourable.

Smallholder Schemes

Smallholder schemes have also met with limited success. Studies have indicated that smallholders are allocating their resources within the livestock sector efficiently (De Boer and Welsch 1977) and also making efficient use of resources within the crop and livestock sector (De Boer 1976c). A number of schemes have been based on producing superior breeding stock for distribution to villagers, including variations of the "Sumba" contract in Indonesia, the "Pawah" scheme in Malaysia, and bull-sharing arrangements in Thailand. Complementary inputs, particularly feed, have not been forthcoming to allow for exploitation of the genetic potential of the distributed animals. Because of unfavourable price ratios, breeding animals are sold soon after distribution. Feedlotting is only viable when a roughage base exists in close proximity to the unit, concentrate feeds of reliable quality are available, the concentrate-beef price ratio is favourable, and the price differential between mature and young animals is not too great. Feedlots have been tried in a number of areas but have not been successful. When the system was based on feeding crop residues, the low roughage quality necessitated using too much expensive concentrate feed. Fresh green chop (maize, tropical grasses) was too seasonal. The premium paid for finished beef was often inadequate and large supplies of feeder cattle could only be gathered at great expense. Beef production based on the development of communal pastures has required a species resistant to heavy overgrazing and tolerant of the dry season. Limited success with this approach has been experienced in Northeast Thailand (Wickham et al. 1977).

Livestock Development: Lessons Learned

Choice of Product

Dairying

Of any area of livestock production, dairying has generated the most legislation, loans, government programs, marketing schemes, and training programs. There are two distinct situations within which dairying development strategy must be examined. First, there are those countries where milk is widely consumed in both rural and urban areas, where dairying is widespread, and the improvement of existing systems is imperative. Such is the case in Pakistan, India, Nepal, Sri Lanka, and Korea. The humid tropics of Southeast Asia represent the second case where milk consumption is not widespread, the available markets are limited to sporadic use of canned milk products in rural areas and fluid milk consumption by higher income groups in urban areas, and dairying is not a traditional, rural enterprise. There are broader choices for starting a dairy industry, but the production and marketing constraints are also more severe.

Crotty (1980) uses a production model to examine critically the "Operation Flood" scheme for milk production in India. His results show that access of large landholders to valuable fodder resources and lower-cost capital will result in a gradual shift of production from small-scale farmers and landless labourers to these larger producers. The plan would raise the price of milk in rural areas and deprive the poor of their major source of animal protein; increase the demand for fodder, which can only be supplied by the larger landholders; reduce food grain availability by increasing the demand for concentrate feed; and reduce the real price of milk to the urban consumers. These results are vastly different from those associated with Operation Flood. Crotty (1980, p. 186) lists several reasons why actual performance is expected to be quite different than the stated objectives and makes a comprehensive set of suggestions for improving the existing production system subject to existing constraints.

Beef Production

There are few success stories that could be repeated over large areas of Asia. The consensus among researchers is that long-term programs are required that centre on simultaneously improving the productivity of both ruminants and nonruminants on the mixed farms that predominate in the region. Beef production, in particular, faces a bewildering set of production constraints on most of these farms. In addition, the demand for draft animal power and the absence of a price premium for better-quality beef work against improved beef production. In many cases, the focus should turn away from large animals toward small ruminants (Devendra 1981a). In some countries, sheep/goat meat sells at a premium over beef. Furthermore, there is no conflict between reproduction and draft power. Resource requirements to get started are smaller and herd expansion is much faster. However, small ruminants have their own particular set of production problems, and the lack of relevant research is even more evident for these species. Finally, small ruminants tend not to lend themselves to large-scale development programs and have subsequently been neglected in national efforts.

Ruminants vs. Nonruminants

The discussion of production systems indicated some important distinctions between ruminants and

nonruminants in terms of location specificity, resource requirements, and comparative advantage. Many rural income problems are caused by an inadequate resource base. Because ruminant production requires access to large supplies of low-cost roughages, the land base must be adequate. This can be achieved by farm expansion, resettlement, reallocations of land-use patterns on existing farms, and intensification of crop/forage production. The pressure on land, which characterizes most of the Asian countries, is, thus, working against large ruminants (De Boer 1976b).

Nonruminants tend to be less location-specific, i.e., less tied to a land resource base for support. Animal feed ingredients can be supplied to selected areas cheaply by bulk transport, and animals can be shipped to assembly points for costs only slightly greater than those incurred by more favourably located producers. The cost disadvantages faced by pig or poultry producers in rural development target areas are relatively small compared to cattle or buffalo producers who have to compete against domestic producers with better land resources and against import competition from low-cost exporters. Therefore, nonruminants deserve careful consideration.

Another factor is the possibilities for integration of stages of production. In many cases, certain stages of the production process require considerably higher levels of technology and management than others. Examples include hatcheries, calf-rearing, and farrowing, which can better be carried out by large commercial firms. However, traditional farmers, utilizing low opportunity cost labour and feed resources, are often competitive in the growing stage. The comparative advantages of the modern and traditional producers were reflected in the Indian government's Draft Fifth Five-Year Plan, which emphasized the use of animal husbandry to improve the economic status of small-scale farmers and landless labourers. The Plan notes that the land and working capital requirements for entering milk production were so high that the richer classes dominated. For small-scale farmers and landless labourers, the rearing of crossbred heifers (where a feed resource base exists), poultry, sheep, and pigs was recommended.

Implications for Project Design

Improved performance will require a much better understanding of the fundamental relationships within the farming system. Far too often, livestock has been seen as a single-dimensional commodity. Insufficient allowance has been made for the multiple purpose animals often serve in a village setting.

The constraint imposed by nutrient supply within the traditional system must be recognized. Strategies must be based on some increases in the volume of nutrients moving through the system. Grazing animals in particular act largely as collectors of low-nutrient materials, which they then supply to humans in a more concentrated source for use as fuel or fertilizer (manure) or as food (meat and milk). The higher the population density and the more intensive the agriculture, the more important this collection function becomes. In very densely populated areas of central Java, cattle are kept in stalls and fed weeds or grasses by hand. All manure is used to fertilize high-value crops such as tobacco and vegetables. Fuel cakes in India represent a similar situation. The ability of animals to supply manure is limited by the supply of nutrients within the system. Eventually the nutrient supply must be increased through the use of chemical fertilizers or legumes. However, the introduction of legumes into various phases of cropping systems or into grazing areas usually requires substantial inputs of phosphorus and sometimes sulfur. Moreover, forages are only as nutritious as the soil in which they are grown so the entire nutrient level of the system may have to be raised. The same holds true in attempts to increase the supply of crop residues and by-products.

Although improvements in livestock marketing and the supply of inputs may lead to short-run increases in production, the dynamic force underlying longer-term expansion in animal production will be the economic growth. This factor will create the demand for livestock products necessary to stimulate producer interest in technological progress related to animal production. With the exception of commercial pig and poultry producers, the current situation is one where the producers' demand for research results and extension services is low because of their perception that substantial changes in the current system are not profitable. Some types of farming systems research, properly designed and executed, could help overcome this problem.

Conclusions

The Asian experience to date has shown that there are no easy answers to rapidly increasing the production of animal products. Widely touted technology packages neglected the enormous variability of farm resources and animal practices in Asia. They did not exhibit adequate understanding of the day-to-day animal management techniques practiced by the farmers and the basic rationale behind these practices. Unfortunately, the need for marginal changes within the complex traditional crop–livestock farming system does not suit the large-scale project approach of governments and donors. The need is,

therefore, for more preproject research, small-scale projects, and a village-oriented, farming systems approach.

There are also a number of important constraints relative to livestock input–output pricing, slaughter regulations, and intervention by public marketing agencies that have not been discussed in this paper. These policies are often critical for project success, and several papers in this volume set out the nature and magnitude of these constraints.

The analysis carried out in this paper also indicates that to meet rural development goals, it should be possible, at modest cost to the public or private sector, to introduce market oriented pig, poultry, or dairy production units into depressed rural areas. India has made efforts in this direction, but results have been mixed so far. Just exactly what type of assistance is needed is not clear, but help in financing initial capital costs would be indicated.

For the ruminant animal sector, private participation has been limited except in the case of dairying. Publicly financed projects have generally not achieved the planned results. Some possible reasons are given above. The major role for the public sector would appear to be in the area of developing and financing long-term, innovative research programs that can deal realistically with the complex constraints faced by the Asian livestock producer.

Livestock Production Issues

To Beef or Not to Beef? Portfolio Choices of Asian Smallholder Cattle Producers

Lovell S. Jarvis[1]

Abstract. In Asia, large ruminants are used principally for draft power, manure, milk, and hides. Beef is an important by-product in some areas and unimportant in others. The secondary emphasis placed on beef is not evidence of inefficiency, but results instead from a set of relative prices that makes beef a less profitable output at the margin and, thus, limits its production. This paper analyzes the factors that determine cattle production, including the ends to which cattle are used. Capital models are specified for male and female animals. Producers are assumed to respond to market parameters to maximize their own incomes. Individual production decisions are related to sector performance. Some government policy options are reviewed.

Résumé. En Asie, les gros ruminants servent principalement d'animaux de trait, en plus de fournir du lait, du fumier et des cuirs. La viande de bœuf est un important sous-produit dans certains endroits, et sans valeur dans d'autres. L'importance secondaire qu'on lui accorde résulte non pas d'un manque d'efficacité mais plutôt d'un ensemble de prix relatifs qui font de la production de viande de bœuf une spéculation moins avantageuse et en restreignent donc la production. Le sujet traité ici étudie les facteurs régissant la production des bestiaux, y compris les fins auxquelles ceux-ci doivent servir. On y précise les rôles essentiels affectés aux sujets mâles et femelles. On suppose que les producteurs réagiront aux paramètres commerciaux en s'efforçant d'accroître leurs revenus. Les décisions individuelles relatives à la production sont reliées à la performance des divers secteurs. On examine également diverses options ouvertes aux décisions des pouvoirs publics.

Asia contains a large proportion of the world's cattle and buffalo populations, 27 and 93%, respectively (Johnston 1975), and yet produces a small proportion of the world's beef, 10%.[2] In Asia, these large ruminants are used principally for other purposes, i.e., draft power, manure (fertilizer, fuel), milk, and hides. Beef is an important by-product in some areas, e.g., Korea, and quite unimportant in others, e.g., India. Nonetheless, the secondary emphasis placed on beef in Asian livestock economies is not evidence of economic inefficiency, contrary to the suggestions often made even by livestock experts. Environmental conditions, farming systems, and consumer demand (income and cultural preferences) result in a set of relative prices that, with the existing technology, makes beef a less profitable output at the margin and, thus, limits its production.

This result is not immutable. The causal factors can be changed and doubtlessly will be changed as economic development continues. Rising incomes and changing preferences in some Asian countries have caused (and are projected to cause in others) an increase in beef (and milk) demand that must be satisfied either by increased domestic supply or by imports, and improved agricultural and livestock technologies, including product processing, may permit several other countries to obtain greater total output, incomes, and welfare via higher beef production for export. Most Asian countries, however, will find it economical to use cattle primarily for draft purposes for some years. This paper analyzes some of the factors determining cattle production, including the ends to which cattle are used. Individual production decisions are related to sector performance, and some government policy options are reviewed. Although the paper cannot take full account of many important technological, cultural, and economic facts in different Asian countries, the simple theory utilized in it offers some useful insights.

The basic model used in this paper was first derived when considering beef production in Latin America (Jarvis 1974). The issues of most interest

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[2]Buffalo and cattle are treated as similar goods (with slightly different input and output characteristics) for which the same basic analysis is valid much as if they were simply different cattle breeds.

in that case were the short- and long-run slaughter response to price changes, and the macroeconomic implications of these responses for countries that were important beef consumers and exporters. The model was subsequently extended to analyze cattle production in some African countries (Jarvis 1980) where cattle provided owners with store of wealth and prestige benefits additional to beef (and other products) and where use of range lands on a communal basis had important implications for individual herder decisions and for total sector efficiency.

Although the same basic model is used here, it becomes substantially more complex because cattle serve many ends simultaneously (so that the joint product problem is much more important) and also form an integral part of the small-scale farmer's overall production-consumption activity program. The maintenance of cattle and the uses to which they are put depend importantly on other household activities. Heuristically, the model considers cattle as both a consumption and a capital good that can be killed and eaten (or their hides, etc., obtained) or they can be used as a production asset to convert feed into beef, milk, draft power, manure, hides, prestige, or religious value. The inherent ability to produce these outputs varies with respect to breed type, sex, and age, and actual production is also strongly influenced by environmental conditions such as climate, disease, parasites, feed (including its seasonal variations), and husbandry. Thus, it is obvious that different farmers operating in different production environments will find some types of cattle more economical than others, and these differences are again magnified by variations in consumer demand for final products like beef and milk.

Because animals must reproduce and do so with approximate male–female parity, any change in the use made of animals of a given age and sex must have repercussions on the uses of other animals and, thereby, on the age–sex structure of the herd. If bullocks are required for draft use, for example, cows are required to produce replacement calves. The value of the calves must ensure that maintaining the cows is profitable when the system is in equilibrium. If less draft power is then required, other things being equal, both the number of bullocks and of cows would decline.

It is possible for important regional variations to appear within the same cattle "system," e.g., some areas can produce surplus replacement animals and sell these to deficit areas, bringing the system into balance. Such regional specialization is limited by transport costs, and by the limited suitability of breed types for different end uses (e.g., milk and draft), or for the same use within different environments (e.g., climate, disease, and parasites). Nonetheless, an important point throughout the analysis that follows is that changes occurring in one aspect of the system, i.e., in the value of draft power, milk, or beef, will have ramifications throughout the cattle system even on those animals that at first appear not to be used for such production. In short, the indirect as well as the direct effects of any parameter change must be considered.

A final introductory clarification is merited. Once a number of joint products are introduced the allocative impact of changes in important parameters becomes complex, and the simple capital model used does not permit a precise solution. Certain results remain unambiguous, although others do not. This degree of ambiguity is frustrating, but its cause is obvious. Activity analysis is an approach that would permit a precise solution to the allocation problem and should be undertaken when such a solution is required. But the simple capital models are useful in sketching out the issues and the solutions in a general way, with much less expense on modeling and development of a data base.

The Basic Model

To facilitate the exposition, some results from previous work are repeated (Jarvis 1974). A simple model characterizes the value of a male calf at birth, $\pi(\theta)$, if this calf is raised only for beef production.

$$(1) \quad \pi(\theta) = p(i,\theta)\, w(i,\theta) e^{-r\theta} - ci \int_0^{\theta} e^{-rt} dt$$

where p = the unit price of beef to be received when the animal is slaughtered, w = the animal's slaughter weight, c = the unit cost of inputs provided to the animal over its life, i = the amount of inputs provided (per unit time), r = the interest rate reflecting alternative investment opportunities, and θ = age of the animal.

Given a calf, the cattle producer can maximize its value, $\pi(\hat{\theta})$ (profits), by choosing the optimum input stream, $\hat{i}$, and the optimum slaughter age, $(\hat{\theta})$, subject to the parameters p, c, and r faced in the market. The conditions for these optima are not derived here, but the first order condition for optimizing θ yields a result that is particularly useful; the optimal age of slaughter occurs when the growth rate of the steer (in terms of salable beef) is equal to the interest rate plus the cost of feeding the animal as a percentage of its value (assuming that the optimun input stream is chosen simultaneously). This is simply a case of setting marginal value product equal to marginal cost:

$$(2) \quad \frac{\dot{pw}}{pw} = r + \frac{ci}{pw}$$

A similar model characterizes the value of a female calf at birth, $\rho(\theta)$, assuming that the calf will be used for breeding and can also be sold for beef.

$$(3) \quad \rho(\theta) = \sum_{t=0}^{\theta} \frac{C(i,t)}{(1+r)^t} - ci \int_0^{\theta} e^{-rt}dt + p(i,\theta)\, w(i,\theta) e^{-r\theta}$$

where C(i,t) is the expected value of a calf born in year t, assuming that the female calf (mother) has been fed input stream i throughout its life. A similar first order condition can be derived for determining the optimum age of slaughter for the female calf as for the male, but the marginal value product of the female must include the current contribution to future calf production as well as beef production.

The most important use of cattle in Asia is for draft power, not for beef, so the models presented above must be changed accordingly. If the male animal is used principally for draft, to be sold for slaughter only after its power has substantially declined, a new benefit term not unlike the calf stream benefit of the cow shown in equation (3) must be included:

$$(4) \quad \pi(\theta) = pw\, e^{-r\theta} - ci \int_0^{\theta} e^{-rt}dt + v \int_0^{\theta} d(i,t)e^{-rt}dt$$

where v = the unit value of draft work, and d(i,t) = the amount of draft work performed by an animal aged t having been fed input stream i during its life. The optimal age of slaughter now occurs where the growth rate of the steer (salable beef) plus its draft services as a percentage of the beef value are equal to the interest rate plus the cost of feeding the animal as a percentage of its value:[3]

$$(5) \quad \frac{\dot{pw}}{pw} + \frac{vd}{pw} = r + \frac{ci}{pw}$$

Given some additional information about the behaviour of the terms in equation (5) over the course of the animal's life, it is clear that the optimal age of slaughter is substantially lengthened if the animal is to be used for draft. First, animals convert feed to beef more efficiently when young so, with prices constant and given any input stream, $\dot{pw}/pw$ declines with age. Second, cattle are not sufficiently developed (strength, docility, training) for draft purposes until they have matured, at which age their feed conversion efficiency will be declining. Thus, the draft term must be the principal factor sustaining a draft animal's life. The animal is removed from service only when its draft value declines, whether by reason of age or illness. It is even possible for the slaughter value term to turn negative and for the animal to remain in use so long as $vd/pw > r + ci/pw$.

Note, however, that the optimal age of slaughter says nothing about the overall profitability of livestock in the system. Nor is a system with lots of old draft animals inherently less efficient than a system with lots of young beef animals. The optimal slaughter age simply indicates when producers find it profitable to replace their capital assets, given their respective uses. Changes in overall cattle profitability are more complex to determine, being reflected in both $\pi(\hat{\theta})$ and in $\rho(\hat{\theta})$, and in the interest rate earned on livestock assets, including the feed ingested by them. To examine cattle profitability, the cattle system as a whole must be examined. This is done by analyzing first a model in which only draft power is desired. Once the general properties are clear, first milk and then beef are added as desirable final products.[4]

The Indian Model

We first assume that cattle are desired only for draft power, which is provided directly only by males (bullocks). Beef has no value. The resulting model characterizes the situation in India where beef has little or no value because of a cultural preference against its consumption. (There is also, among some Indians at least, a cultural preference against the killing of cattle (Jasiorowski 1976; Williams 1976).) Sandford (1978) estimates that beef accounts for only about 1% of the value of cattle output in India, with 60–80% received as draft services, 10–20% as manure, 7–15% as milk, and 1–2% as hides. Cattle may also offer benefits as a store of value or a prestige good, but these, like manure, can be treated

[3]For mathematical simplicity, it is assumed (a) that the animal is fed the same input stream over its entire life and (b) the current draft services reflect the proper decision criteria. Although not fully correct, the resulting model is useful for highlighting decison choices.

[4]In an interesting article written some years ago, Raj (1969) developed a similar theory of portfolio analysis and showed that in India regional variations in the density of livestock, as well as the age and sex composition of the herd, were related to economic variables in a predicted manner. In particular, he argued that the large bovine population in India was not the result primarily of religious or cultural restrictions on the slaughter of old unproductive animals, but rather depended on the profitability of cattle (however low their productivity) on millions of small farms.

analogously to the draft function. For analytical simplicity, all but draft are excluded in this model.

Heuristically, we know that a farmer will wish to retain a bullock so long as the present discounted value (PDV) of future draft services less maintenance costs is positive. It is easy to graph a situation where draft services exceed maintenance costs over some age range, with this difference gradually declining to equality at which time draft use ceases. The farmer must know something about the way animals age when "applying" the first order conditions for a maximum, however, to ensure that a global maximum is obtained. Animals will not produce draft services until they have reached some minimum age, θ_1, and they will not work continuously, being idle between peak agricultural seasons and perhaps during periods of illness. The optimal feed ration will also vary, both with their size and age, and with the work program they are expected to perform. Expectations regarding the future strength of an animal, including the probability that it will be able to complete important tasks, play an important role in the decision to retain or dispose of the animal.

We have already established that slaughter will occur at an older age when draft is the principal output sought (see the discussion of equation (5)), and a different focus is useful here. For analytical simplicity, we assume that the value of draft services is zero until age $\theta_1 > 0$, and then is uniformly higher than the cost of maintenance until the animal ceases to perform (with certainty) at age T, analogous to the end of the classic one-horse shay. The model for male cattle is then as follows:

$$(6)\quad \pi(\theta) = \text{vd} \int_{\theta_1}^{T} e^{-r\theta}dt - \text{ci} \int_{0}^{T} e^{-r\theta}dt$$

Obviously, draft use occurs from θ_1 to T, provided that $\text{vde}^{-r\theta_1} > \text{ci}$. The interest rate affects the decision to use the animal, via θ_1, but does not affect the decision to stop use, once initiated.

This situation is graphed in Fig. 1, parts (a), (b), and (c). In (a) the cumulative total maintenance (feed) costs and draft services are graphed against θ. In (b) we see that PDV's of these flows asympotically approach limits as θ increases. The θ_1 is important in the limit approached for the PDV of draft services. It is not profitable to raise the bullock unless the animal can be used from at least θ_1 to θ_2. The difference between the discounted draft services and the discounted maintenance costs, at each θ, yields the capital value of the calf at birth, $\pi(\theta)$, when used to said age θ. The $\pi(\hat{\theta})$ occurs at T, as indicated. Part (c) shows the market (capital) value of the animal, VM(θ), for all θ, which under the assumption of homogeneous animals and perfect markets equals the supply cost of producing such animals:

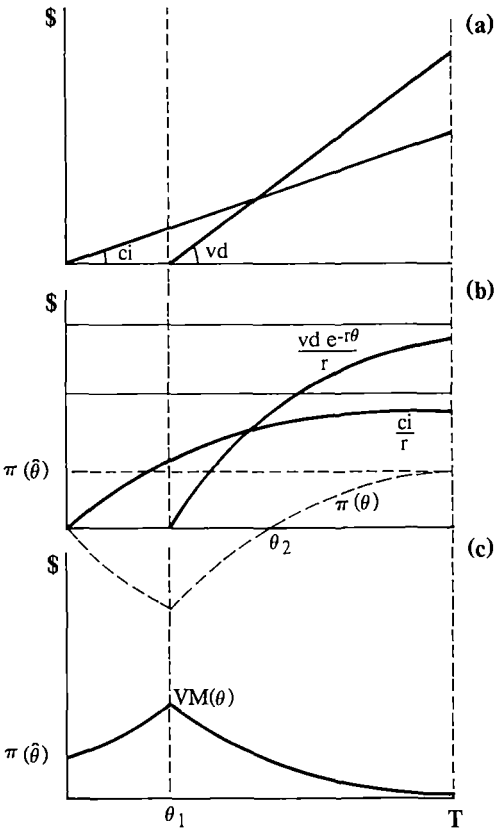

Fig. 1. Model of a male calf when raised only for draft.

$$(7)\quad \text{VM}(\theta) = \pi(\theta)e^{r\theta} + \frac{\text{ci}}{r}(e^{r\theta} - 1) - \frac{\text{vd}}{r}(e^{r(\theta-\theta_1)} - 1)$$

VM(θ) is highest at θ_1 when the costs of raising the animal to maturity have been incurred and its entire productive life is still ahead. This market value declines monotonically thereafter to zero at T, when no more production is forthcoming. The zero value at T is a potential source of market imperfections, as is shown below.

The model presented assumes that productivity ceases at T, although the animal need not die. It is simply worthless from this age onward, and any profit-maximizing owner would refuse to feed it subsequently (if incomes are low and the available feed is needed for other productive animals, the pressures for profit maximization are strong). In the model

shown, disposal costs are zero, but this may not be the case. If positive, i.e., if the owner would have to incur costs to get someone else to take the animal away and/or feed it, say in Z amount, $\pi(\hat{\theta})$ should be reduced by the PDV of disposal costs (Ze^{-rT}). If included appropriately in the model, the profits of breeding calves will be reduced and, ultimately, the supply of calves. That is, the disposal costs will (efficiently, given real disposal costs) decrease the attractiveness of using bullocks for draft power so that fewer will be employed.

Suppose, however, that some farmers wish to avoid the costs of disposal and are able to simply turn the animal free to forage on its own. If the owners are successful in denying the abandoned bullock access to their own forage and crops, the private disposal cost is then turned into an externality. The bullock now consumes communal forage that might be used for other animals (an additional inefficiency to that commonly occurring with communal land without controlled grazing access (Jarvis 1980)), or consumes other farmers' forage and/or crops. These farmers must then accept additional costs to fence out or otherwise control the abandoned bullock, pay the disposal costs themselves, or suffer continuing damage. However, these costs do not affect $\pi(\hat{\theta})$, and, thus, the total number of bullocks bred and used is (inefficiently) not reduced.

Although considerable emphasis has been placed in the literature on the feed wasted on maintaining old, unproductive cattle in India, simple, back-of-the envelope calculations suggest that the required rations of minimum subsistence for animals beyond their productive age (to death) is probably rather small relative to the costs of the entire livestock system. Adult mortality is rather high in India even for those male and female animals that are considered productive (about 10%), so that relatively few animals (as a proportion of the total herd) live beyond their productive ages. As animals age they also need relatively lower maintenance rations. I suspect that the costs of maintaining unproductive animals in "cattle retirement homes" (Williams 1976) would, if implemented, not require more than 5–7% of the total forage used for cattle. Nonetheless, in a country that is dreadfully short of feed for both cattle and humans, this amount is important. The point I would emphasize, however, is that the damage done by uncontrolled foraging cattle could easily exceed this amount. There could, thus, be an economic as well as a cultural-humane justification for receiving such animals in public institutions.

Equally important, the establishment of government slaughterhouses (Jasiorowski 1976) would provide beef for export (foreign exchange), if this were culturally acceptable, and would simultaneously establish a private incentive for the disposal of unproductive animals, thereby eliminating the source of the externality. The gains from avoiding the losses caused by foraging old cattle could approximate the value added from the slaughterhouse operations themselves. With 150 million cattle, and assuming that 7% might be culled and slaughtered each year and farmers paid U.S.$50 per head, the gross amount received annually by farmers would be U.S.$500 million. Such benefits would increase net farm incomes in equal amount and, by making cattle production more profitable, would actually encourage use of draft animals.

Consider now the model for cows. Assume first that the cow is useful only for breeding, i.e., it is not used for draft. The equation is identical to equation (3), minus the third term on the right-hand side. Because cows will produce calves only after reaching maturity (θ_a, around 4 years in India), a graphical presentation of the cow model would have a highly similar appearance to that provided for males in Fig. 1, save that the calves are produced discontinuously. The market value of a cow, $VF(\theta)$, reflecting both the costs of maintenance and the benefits of calves, must decline after θ_a in a stepwise manner, reaching 0 at T on birth of its last calf (the finite limit to productivity is retained for simplicity).

More important, $\rho(\hat{\theta})$ ultimately depends only on $\pi(\hat{\theta})$, the value of bullock calves. This is too strong an assertion in one sense. Female calves have value because they provide the means of reproducing the male calves. Improvements in breeding efficiency, i.e., the age of first calving or the frequency of calving, or any reduction in maintenance costs will increase $\rho(\hat{\theta})$. But if cattle are used only for draft, such services must pay for both the direct and indirect maintenance costs, i.e., those of the draft animals, the breeding cows, and the immature animals being raised for draft and reproduction. The $\pi(\hat{\theta})$ and $\rho(\hat{\theta})$ must be such that each farmer earns interest rate r (assuming homogeneity of animals, farms, farmers, etc.) on all cattle assets, including their embodied feed costs, over their lives. If the value of draft services increases, this will be reflected in a higher vd and a subsequent increase in $\pi(\hat{\theta})$ (or a higher r earned on existing cattle assets), calling forth higher production of calves. The larger resulting number of cattle would also probably result in a bidding up of feed and other maintenance costs, partially but not completely offsetting the effect of the higher vd (the demand for feed is a derived demand here). The net amount of draft services performed must rise in equilibrium, as will both $\pi(\hat{\theta})$ and $\rho(\hat{\theta})$.

Similarly, a shift in the productivity of cows can affect the profitability of draft bullocks. If cow fertility declines, the profitability of keeping cows to produce bullock calves would decline, with a subsequent decline in the number of such calves pro-

duced. Assuming that bullock use was subject to diminishing returns, bullock use would contract until the higher marginal value of draft services performed provided for a $\pi(\hat{\theta})$ sufficiently high to maintain the associated flow of bullock calves (at required interest rate r earned on all assets).

Also, although the models presented are based on the assumption of homogeneity, e.g., identical animals and farms, there will be a wide dispersion of types giving rise to systematic patterns in the type and number of animals held on different farms. For example, the capital cost of an animal age θ (equation (7)) is given under the assumption that all animals are biologically equal and that all farms have the same cattle maintenance costs, c, and the same demand for draft services, vd. However, if maintenance costs and the demand for draft services vary across farms, the capital cost will be given by an equilibrium "average" of these parameters. Clearly, farmers with higher than average costs will be able to own a draft animal only if they also have higher than average demand for draft services, or if they are willing to accept a lower than average r on their investment in the draft animal over time. (With the lower vd and higher ci, farmers cannot purchase an animal at the market price, $VM(\theta)$, and still earn r on the investment over time.) They could find it more profitable to rent in the draft services needed and rent out the feed possessed. Alternatively, they might purchase a smaller, older animal whose feed needs and performance, as well as market price, were lower. Similarly, changes in sector parameters, as occur from a bidding up of maintenance costs, will affect the marginal users of draft animals first. Other farms, which earn inframarginal rents, will have these rents reduced, but will not cease to use draft animals.

The Indian Case: Milk

Although beef is not sought in India, milk is an important cattle output and is becoming steadily more important (Somjee and Somjee 1976; Mogens 1978; Brumby 1981). It is useful to analyze how the addition of milk production affects the results previously derived. The model for male calves remains the same, and the model for female calves is now similar to that presented in equation (3), save that the third term on the right-hand side now represents the value of milk produced instead of beef value. The new term is nearly identical in form to that of draft services, as milk flow will begin only when maturity is achieved (and the first calf born) and continue throughout productive life.

We first assume that maintenance inputs are held constant. The milk output is, thus, "free," being additional to the calves produced (the addition of the milk term can be treated as an increase (from zero) in the price of milk). The $\rho(\hat{\theta})$ rises. The higher profitability of female calves causes an expansion of the cow herd, a greater supply of female calves, and, as male and female calves are joint products (over time), the supply of male calves will also expand. But, with unchanging demand for draft services (and assuming diminishing returns to bullocks), more bullocks can profitably be used only as the value of bullock calves, $\pi(\hat{\theta})$, declines. This is shown heuristically in Fig. 2; as the price of bullocks falls, it is profitable to expand bullock use from B_1 to B_2. (The price of bullock calves is only one part of the cost of draft power, but a decline in this price, other things being equal, will reduce total costs.) Note, moreover, that net income rises on farms using draft power both by the lower cost of bullocks times the number of bullocks previously used, $(\pi(\hat{\theta})_1 - \pi(\hat{\theta})_2)B_1$, and also by the value added as a result of increased use (analogous triangle).

This example is somewhat artificial, but its purpose is to emphasize the benefits that can accrue to the users of draft services from an increase in the value of milk produced by cows, demonstrating again the important interactions within the cattle system. Obviously, had cow productivity been increased by improved fertility, directly lowering the cost of calves, the result would be straightforward. As it is, an increase in the price of this joint product is probably, but not necessarily, beneficial. Given the birth parity between males and females, with higher $\rho(\hat{\theta})$, both the male and the female herds expand. However, if milk production is highly sought,

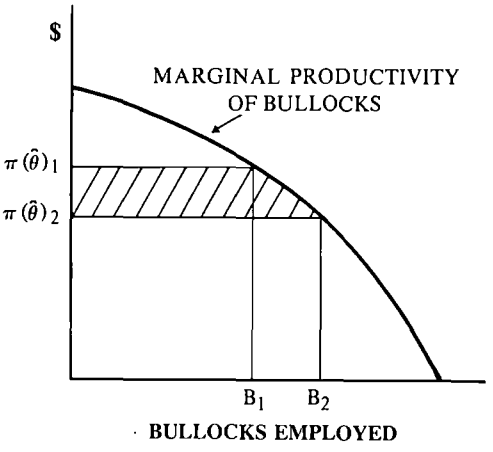

Fig. 2. The impact on bullock use and on net farm income from lowering the price of bullock calves.

if much more milk can be obtained from a single cow by substantially increasing the feed ration, and if the feed for cows is the same as for bullocks, the quest for milk can result in a substantial bidding up of the price of feed (c). (Draft power constitutes a significant part of cultivation costs, but most of these are associated with feed inputs, not the (interest) cost of the bullock calf. Thus, the decline in $\pi(\hat{\theta})$ should not greatly reduce c, other things being equal.) It is conceivable, even if highly improbable, that the value of bullock calves, $\pi(\hat{\theta})$, could be driven to zero by the increase in the number of calves and the rising c, with the number of bullocks being used for draft actually decreasing (the other bullock calves being killed.)[5]

Regardless, whether the benefits are obtained by draft users or cattle breeders, total farm sector income increases when the value of milk increases.[6] The livestock asset has suddenly become capable of producing more valuable output for the same feed input. In perfect markets, the owners of the (fixed) land that can produce the feed and, thereby, the (fully reproducible) cattle asset will benefit.

For additional variation, we could first assume that cows perform draft services as well as produce calves (but no milk). The $\rho(\hat{\theta})$ will rise, but $\pi(\hat{\theta})$ will fall due to the expanded supply of draft services. In equilibrium, the herd will be larger and both breeders and draft users will have gained vis-à-vis the situation where cows produce only calves. If, however, cows perform draft services and also produce both calves and milk, an increase in the demand for milk again has an ambiguous impact on the supply of draft services. If there is a production conflict between the use of cows for milk and also for draft — a highly likely conflict — an increase in the demand for milk is likely to reduce the supply of draft services.

The Beef Model

We turn now to cattle systems where beef has value; for simplicity, assume that bullocks produce draft and beef, and cows produce calves and beef. Milk has value only for feeding calves. The model for bullock calves was presented in equation (4). The equation for heifer calves is similar, with the calf term replacing the draft services term.

In the discussion of equation (5) (first order condition derived from equation (4)), it was shown that a draft animal would be sold at an older age than an animal raised solely for beef. Conversely, however, if an animal is used both for draft and for beef, and if the price of beef suddenly increases, the optimal age of slaughter, $\hat{\theta}$, probably will be reduced (from this higher age).[7] This occurs because the interest rate plays a more forceful role as a heavier weight is placed on the slaughter value being foregone. The result is certain if the bullock's weight gain or loss as a function of age is zero, as is likely to be true for a mature bullock.

The price effect need not reduce the number of draft animals used, however, as the older animals may simply be replaced by younger animals. To determine the effect on the number of draft animals used, the impact of a price increase on $\pi(\hat{\theta})$ and $\rho(\hat{\theta})$, including repercussions, must again be analyzed. Figure 1 showed the situation for male animals used only for draft. Figure 3 shows a similar set of diagrams for male animals used for both draft and beef production. If the price of beef rises (from zero), $\pi(\theta)$ is maximized by holding the animal to age $\hat{\theta}$, shown in (b′) as the net PDV from the curves in (b). The $\pi(\hat{\theta})$ is higher as a result of the beef term by $pwe^{-r\hat{\theta}}$. In equilibrium, each draft user pays a higher price for bullock calves than is justified by the draft services received, but recovers the extra amount, including interest, at $\hat{\theta}$ when the animal is sold. The higher $\pi(\hat{\theta})$ offers no direct benefits to the draft user or, rather, none that could not be earned by investing in another asset whose expected return was r. The market (capital) value of the bullock, $VM(\theta)$, lies uniformly above pw until $\hat{\theta}$. (The value of a calf at birth could still exceed that of an old draft animal, but this seems unlikely.)

If cattle are maintained for draft and beef, what effect will a beef price increase have on the use of cattle? First, the higher beef price should result in the slaughter of all bullocks and cows at a lower age in equilibrium. The adult herd, thus, will be renewed more rapidly. With these adult animals slaughtered earlier, the average age of the herd will decline, and

[5]The result is not so improbable, however, if specialized milk animals are introduced, i.e., either milch buffalo or crossbred exotic cows. These will consume more feed than the breeding cow and, because their bullock calves make poorer draft animals, the quest for milk becomes rival rather than complementary to draft production.

[6]Breeders and draft users may be the same individuals, but need not be.

[7]A simple proof is the following. In equation (5), let pw = c, and denote the other terms as follows: $a/c + b/c = r + d/c$. If, as assumed, $a = 0$, then the animal is held only so long as: $x = b/c - r - d/c = (1/c)(b-d) - r > 0$. But, $dx/dc = (1/c^2)(d-b) < 0$, if and only if $b > d$, i.e., if the value of draft services is greater than the cost of maintenance. This must be true for animals still in use. Thus, if x is close to zero, a beef price increase can prompt slaughter of male bullocks, contrary to the expected *ceteris paribus* result when steers are raised solely for beef.

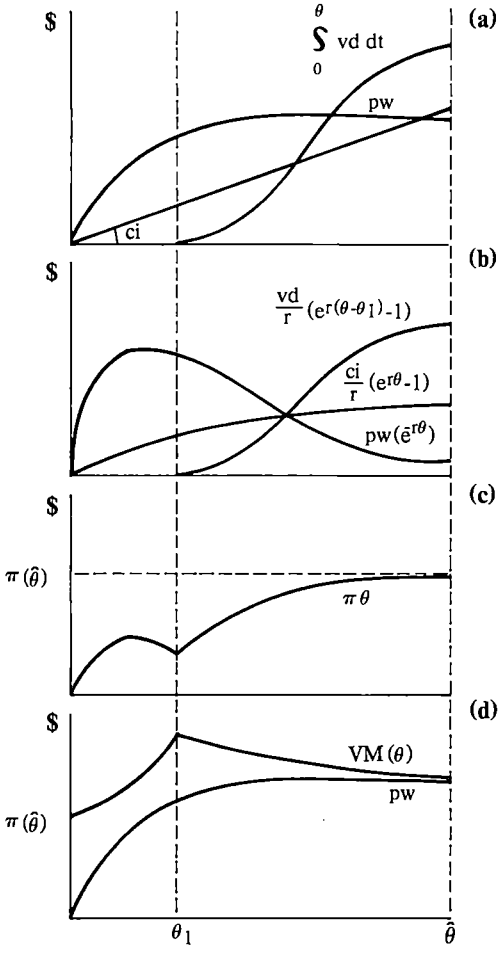

Fig. 3. Model of a male calf when raised for draft and beef production.

each cohort must be larger if the same total number of draft animals is to be used. Thus, total annual slaughter will increase.[8] Second, the higher beef price also will result in higher $\pi(\hat{\theta})$ and $\rho(\hat{\theta})$, leading to a larger breeding herd. The calving rate should also increase, both because cows are slaughtered at an earlier age (assuming declining productivity with age) and because the higher price of calves justifies greater expenditure (higher feed input, veterinary expense, etc.) to achieve higher age-specific calving rates.

But the resulting larger herd — draft animals, breeding cows, and replacement animals — cannot be maintained on higher average rations without an expansion of feed supply, and any such expansion will probably increase the cost of feed, assuming that such supplies are not completely elastic. This cost increase would offset, partially or completely, the higher profitability of using bullocks as draft animals as a result of the higher beef price (which permitted the direct feed costs of bullock maintenance to be partially amortized by the beef term).

However, the increased feed costs can wholly offset the higher profitability of using bullocks for draft animals only if (after) some of the male calves are raised for beef alone. Consider again the curves in Fig. 3. A higher beef price, say $\lambda\rho$, will shift upward the curves reflecting slaughter value by λ. As a result, the curve for $\pi(\theta)$ will rise absolutely much more for early ages than for later ages (part b'). Any increase in feed costs will shift up the curves for this component, but these will rise absolutely more at higher θ than at lower θ, reducing the attractiveness of draft services relative to that of beef. If the price of beef rises sufficiently, a bimodal optimal age of slaughter will occur with $\pi(\hat{\theta})$ reaching an equal maximum for calves raised for beef alone as for those raised for draft and then slaughtered after such use. The situation for cows is identical: cows can be raised for beef only, or for reproduction and for beef. (Jarvis 1974).

The shift discussed is not a knife-edge. Ten percent of the animals can be slaughtered for beef alone and 90% used for draft, or any other proportional division. The relative proportions will change as the price of beef and the cost of feed are altered. The shift toward more beef must eventually be marked, however, by a reduction in draft animals even though the total herd size may continue to increase. The age composition of the herd will be lower and, given that some animals are slaughtered at an early age (whether male or female), the sex composition of the herd at older ages is likely to vary more sharply.

Again, it hardly needs to be mentioned that a rising price of beef will result in higher farm incomes even if these farms gradually give up their bullocks and turn to other means of cultivation (labour, mechanization). Use of the bullock for draft becomes an inefficient use of the cattle asset given the high price of beef, as this asset is more profitably used simply to produce beef.

[8]For reasons of space, little emphasis has been placed on determining the optimal feed ration, $\hat{\imath}$, or changes therein. This issue is as important as the optimal age of slaughter, particularly when changes in productive use are contemplated. The interaction between $\hat{\theta}$ and $\hat{\imath}$ is often empirically important. In the case considered, a higher beef price would increase the ration fed just prior to slaughter, probably resulting in heavier slaughter weights. Thus, beef production from the adult animals slaughtered would increase more than proportionately to the increase in number slaughtered.

Small Farm Characteristics and Dual-Purpose Animals

The models presented have focused on the effect of changing demand conditions for two products, beef and milk, on cattle use. The models were highly abstract and designed only to sketch out the situation. Many important details should be added, but only a few can be discussed here.

All cattle provide a number of useful products, i.e., every sustained cattle system provides beef, milk, manure, and hides as well as calves. Nonetheless, the demand for these different products may vary substantially from one context to another so that some outputs are emphasized in some areas in much greater degree than in others. In some systems (or subsystems), draft power is not used. In others, the unused potential may be milk or beef. Furthermore, because some animals are genetically better suited to produce one (or more) outputs than are other animals, breeding to obtain specific production characteristics results in whole populations that are relatively specialized.

The cattle used on smallholder farms in Asia have evolved to provide efficient draft service under circumstances that are frequently quite harsh: heat, humidity, disease, external and internal parasites, poor feed, and relatively limited husbandry practices. These cattle need to be able to survive on meagre rations and yet have sufficient strength to perform the needed draft functions. These same animals may have potential to produce beef and milk economically if the production emphasis is shifted. But whether these animals, or other breeds, are used will depend a great deal on the specific production environment and how this environment evolves with time.

Cattle in Asia are particularly useful to the extent that they feed on roughages and farm by-products that cannot be fed to humans and/or utilized for other purposes. In India, for example, cattle are fed principally on wheat and rice straws; half the gross energy present in the organic matter of India's rice and wheat crops is found in such straws (Ranjhan 1978). This energy would be largely wasted if it could not be consumed by ruminants. Lands unsuitable for cropping, e.g., local commons, roadsides, and forest or public range lands, as well as fallows provide additional ruminant feed. It is estimated that about 60% of cattle feed comes from farm by-products and about 40% from natural vegetation (Groenewold and Crossing 1975). The ruminants also provide manure (fertilizer), which is badly needed for crops and would otherwise have to be purchased.

Ruminants have the capacity to degrade (digest) and use for synthetic purposes substances that cannot be used by humans. Ruminants can create their own protein from structural carbohydrates and live under conditions where protein would otherwise be deficient. But cattle require some glucose and some preformed protein if they are to operate at a high level of productive efficiency (Preston 1977). Straw, although cheap, has several nutritional weaknesses, as it supplies little crude preformed protein, a relatively low level of metabolizable energy, usually low levels of minerals and vitamins, and has low digestibility (Wilson 1980). Straw can provide improved nutrition if treated (about a 50% increase), but both chemical and physical treatment is expensive, reducing its economy, and straw is a poor feed even after treatment.

Cattle do not require high-quality rations for all purposes. For example, treated straw has permitted sufficient development in yearling Friesian dairy cattle for calving at 2 years even without supplements (Smith et al. 1980), but such a ration is not sufficient to permit high outputs of milk, beef, or even sustained draft work. On most smallholder farms in Asia, however, draft animals are required for plowing only for a limited number of weeks in the year and, except for this period, the animals may be quite ill fed. Although the strength and endurance of the animal can be increased through improved feed, owners provide such feed only to the extent that increased strength is needed for the task at hand. Increased feed, or other maintenance, may not be profitable given the limited scope for higher animal physical productivity to be reflected in higher value of household final output (Raj 1969). On the other hand, milk is required continuously over the year and, as the output depends significantly on the feed provided, higher quantity and quality feed is required, on a regular basis, for efficient production. Intensive beef production also requires higher and more regular feed rations (McMeekan 1960).

As Preston (1977) has emphasized, the climate and nutritional restraints in most of the tropical developing countries (including much of Asia) would prohibit efficient production from specialist (e.g., milk or dairy) animals even if such herds were currently present. These tropical regions produce lots of dry matter, but matter of only moderate nutritive value, that is best suited for moderate rates of production and not for the high nutritive demands of specialist operations. To the extent that cattle are fed more nutritious supplements, they compete more directly for food with humans. Preston points out that dual-purpose systems, e.g., beef–milk, are more energy efficient (about 44 vs. 34%) for the same mix of final products than specialist systems and suggests that in many developing countries, at the current levels of product demand and feed supply, such systems will be more economically effi-

cient as well. The models presented in this paper have similar implications.

A Shift from Draft to Beef: the Korean Case

Since 1965, beef output in Korea has expanded rapidly, about 10%/year, in response to rising real incomes and a moderately high rate of population increase. Johns (1980) indicates that, since 1971, growth in the native herd also has been rapid, expanding from 1.25 million in 1971 to 1.90 million in 1981. The specialized beef herd grew more rapidly, from 3000 to 100 000 over the same period, but the bulk of the South Korean herd is still composed of native cattle (82% in 1981), with 5% being specialized (imported) beef breeds and 13% specialized dairy breeds. Rough calculations suggest that about three-fourths of the beef produced now comes from the native cattle herd, which produces fat steers and heifers as well as cull cows and cull bullocks. Thus, the native herd has held up well in the transition.[9]

As the herd expanded, the average slaughter weight also rose from 100 kg in the years 1963–68 to 209 kg in 1973–78. The herd expanded by 34%, slaughter by 30% (with part of production going to continuing herd buildup), the extraction rate rose by 36%,[10] and the average slaughter weight by 93%. These results are consistent with the theory advanced earlier. The rising price of beef should induce a gradual shift in the allocation of resources toward beef, prompting a rise in the extraction rate. Had only cull animals been sold in the initial situation, average slaughter weights could have dropped as increased emphasis on beef production could have produced only light steers. Instead, with high prices and the draft demand still competing for animals and feed, it has been profitable to feed "beef" animals a large ration of concentrates to achieve high weights at an early age. Because small farms in Korea cannot efficiently supply this feed, increased beef production is dependent on the growth of imported feed concentrates as the data confirm.[11] It is likely that the increased value of beef production is leading to a rapid decline in the number of bullocks used, with the limited cheap feed on each small farm being devoted increasingly to the maintenance of breeding cows. Increased beef production may be a major cause as well as result of increased mechanization.

The data suggest that small farms do not have sufficient by-products to raise many more animals, but they have allocated their existing feed increasingly to breeding stock and have then begun to produce and/or purchase concentrate feed for intensive fattening of animals destined for slaughter. The dual- or triple-purpose system previously in operation was well suited to the production of substantial beef at moderate prices, but can produce large quantities of (higher-quality) beef only at very high prices as the amount of low-quality feed is exhausted and, subsequently, all marginal output must come from high-cost inputs. There is some room for expansion by shifting feed from draft to beef (breeding), but only by providing draft power from alternative sources.

Government Policy Issues

Concern is expressed in several Asian countries that a declining cattle–buffalo herd is reducing the amount of draft power available. This trend appears undesirable in light of the projection made by the Food and Agriculture Organization of the United Nations (FAO) that more draft animals will be required in future decades to permit increased cropping intensification. Mechanization can fill part of the increased draft demand, but animal draft power still appears to be the most economical power source on most farms and is likely to remain so, especially if average farm size declines (under growing population pressure) and if fuel prices rise.

The stagnation or decline in the cattle–buffalo herd has been positively correlated in several countries with rising real beef prices and increased animal slaughter, making it appear that higher beef demand is the cause of declining herds.[12] Both Indonesia and Thailand have prohibited male and female slaughter until animals have reached advanced age, e.g., 10

[9]The herd data in Johns (1980) are somewhat different from those in Shim (this volume), which show that the Korean cattle herd declined after 1978 and that most of this decline occurred in the native cattle herd. The main points made in this section would not be changed, however, by use of the more recent and more accurate data in Shim's paper.

[10]The extraction rate was measured as slaughter plus the change in herd size, divided by the herd in year $t-1$. Because the data show pronounced cycles, period averaging was used to obtain a more valid indicator of the tendency through time.

[11]Mixed feed used for beef production rose from 7000 t in 1971 to 96 000 t in 1977. Of grain feed, 56% was imported in 1971 and 66% in 1977. Korea produced (average) 5.6 t of beef per tonne of grain feed in 1971, but only 0.8 t of beef per tonne of feed in 1977.

[12]Rapidly rising beef prices have been associated in Korea with a rise in herd size, although the proportion of the herd used for draft purposes seems to have declined.

years, hoping thereby to prevent their diversion to beef production. This effort to increase the availability of draft power is sometimes justified as a means of increasing farmer welfare on the assumption that farmers' short-run actions are inconsistent with their own long-run interests and at other times in the belief that rising beef consumption is decreasing the supply of staple agricultural foodstuffs.

The theory developed in this paper suggests that slaughter regulations are not an attractive policy instrument to reach either of these goals. They will certainly reduce farmer incomes and they may or may not increase agricultural as opposed to beef output. Even if they increase agricultural output, they do so inefficiently. Moreover, the decline in herds is probably not the result of rising beef prices, nor economically bad.

Farmer irrationality is sometimes alleged because some farmers sell their draft animals for slaughter after a beef price increase, as if attempting to realize an unexpected capital gain. The declining herd is then used to suggest that these producers remain without draft animals subsequently. In fact, the theory outlined above indicates that slaughter of old males in a response to a beef price increase is not myopic, nor otherwise irrational; a beef price increase should induce the slaughter of old draft animals, followed by their replacement with younger draft animals. Because the higher beef price also increases $\pi(\hat{\theta})$ and $\rho(\hat{\theta})$, making breeding more profitable, it should cause a larger, not smaller, supply of calves to encourage these replacements.[13]

Indeed, it appears that the herd stagnation in Indonesia and Thailand is explicable by numerous nonbeef price factors. For example, the opportunity cost of labour has risen with more intensive cropping, greater off-the-farm labour opportunities, and rising school attendance (by children who used to tend livestock). Thus, an important component of input costs, c, has been rising, making livestock maintenance less economical.

The average size of farms has also gotten progressively smaller, e.g., in Java, reducing the draft work to be performed per cultivation cycle. A smaller amount of draft work, d, per farm will not reduce the aggregate need for draft power, but does make it attractive to substitute human labour for animal power in some operations on some farms and also facilitates the draft use of cows, which are somewhat weaker than bullocks. Availability of more-efficient and less-expensive machinery (because of technical change in industry or biased economic parameters, e.g., exchange and interest rates) reduces the value of livestock draft services, v, and has caused machinery to substitute for cattle on some farms, particularly larger farms where the owner is concerned with problems of labour administration and/or can afford to purchase the "prestige" associated with machinery. Improved roads and rural transport facilities may also reduce the value of (net) transport services provided by cattle, which correctly form a component of draft services, v.

A rise in the discount rate, r, perhaps as rural investment opportunities improve, will shorten $\hat{\theta}$ and, *ceteris paribus*, reduce total herd size, which must shrink so that the stock of animals yields a higher return.

All factors cited reduce the profitability of using cattle for draft use and, *ceteris paribus*, a decline in the number of draft animals should be expected. This change should be permitted insofar as it reflects changes in both private and social costs. Although the effects described could be offset by an increased demand for draft animals, resulting from intensified cropping, important developments at the farm level, unassociated with the demand for beef, are working to reduce the demand for draft cattle. Accordingly, failure of the cattle herd to grow may not be economically bad, but simply reflects farmers' intelligent responses to changes in the price structure.

Also, the productivity of draft animals may be increasing. Increased productivity will result in increased use of animal draft power, but, with rising output per animal, fewer total animals might be needed. Thus, a declining herd does not necessarily indicate that the potential amount of draft power is declining. One of the principal means by which the amount of draft services performed per animal unit can be increased is to bring female animals into direct use. Increasing use of female animals is expected with rising maintenance costs, c, which makes retention of cows uneconomical for breeding purposes only. The effect is amplified if declining plot size reduces the amount of work to be performed per unit of time.[14]

Another source of rising animal productivity is improved animal husbandry and veterinary practices. These reduce the probability of death (Panayotou and Tokrisna, this volume), and increase the animal growth rate, the calving rate, and animal strength and endurance. Rising productivity will increase the demand for animal services but also reduce the number of animals needed per unit of draft services performed. Any improvements in comple-

[13]Slaughter of breeding cows in response to a beef price increase is much less frequently asserted and such slaughter ought not to occur.

[14]Panayotou and Tokrisna (this volume) provide both a theoretical and empirical illustration of this phenomenon in Thailand.

mentary inputs, such as cultivation implements, should have a similar effect.

Increasing animal productivity should be reflected in a higher capital value for animals and/or in a higher rate of return, r, achieved. A partial test of this hypothesis might, thus, be obtained from data on the real prices of livestock over time. Regardless, we ought to be cautious before inferring that the supply of draft services is proportionate to the size of the cattle herd. It is commonly asserted that animal productivity increases have been small in recent years, but better data are surely needed before such hard and pessimistic conclusions are made.

Because of the potentially complex interaction of the economic parameters affecting livestock profitability, producers must continually determine whether each animal, if retained one more period, will produce more than it costs to maintain it. If not, it should be sold. The producers have experience with the animal and, thus, know its production characteristics intimately. They are also aware of the feed situation and the work to be accomplished. Thus, they are in a far better position to make a decision concerning slaughter than is the government. Prohibition of slaughter until some fixed age is a specific attempt to extend the slaughter age beyond that chosen by the producers, i.e., beyond $\hat{\theta}$. But the models show clearly that the sale of any animal at any age different from $\hat{\theta}$ will result in lower livestock profitability and, thus, lower livestock output. Farm incomes, which depend on the use of livestock to convert feed and labour inputs into valuable outputs, must also decline.

Because producers recognize these facts, they are rarely completely deterred by slaughter regulations if they decide that it is no longer profitable to retain an animal. They seek to evade the regulation. Evasion may require certification that the animal is infertile or sickly. If required from a veterinarian or an official inspector, an extra charge or a bribe may be necessary. If this is too expensive, the animal may be "accidentally" crippled so that slaughter becomes the only alternative or the animal may be sold for illegal, clandestine slaughter. Regardless, the regulations impose higher transactions costs on producers, create fear and uncertainty, and result in lower producer beef prices. Most animals are owned by small-scale farmers, who are the individuals most harmed. The producer whose animal is relatively infertile, difficult to handle, or susceptible to disease or parasites, and who has, therefore, already suffered a capital loss, has this loss compounded by the slaughter regulations.

In one situation the above argument is perhaps too strong. Some farmers may wish to sell an animal that is still productive, perhaps to raise cash for a family emergency or because their own need for draft or breeding animals declines due to production changes. Theoretically, the animal should be sold to another farmer for additional use, not sold for slaughter. However, the farmer who is selling may not be able to get the animal's true capital value in the secondhand market because of the "lemon" principle (Akerlof 1970). There is an asymetry of information between the seller and the prospective buyer regarding the animal's potential productivity. Buyers, unless they know the sellers well and are able to trust their statements, will have difficulty determining the true motive for sale and, thus, assessing the animal's true potential. Knowing that most animals are sold only when they have some serious defect, the buyers may attach a high probability that this animal too is a "lemon" and, thus, discount its true capital value substantially. The sellers could then find it equally profitable and easier to sell the animal for slaughter.

The problem should be more serious for older animals because the capital value and slaughter value are then already close. Regardless, there is no easy solution. A "review" process at slaughterhouses has been suggested, with all animals being purchased for their beef value by the government, but then examined for potential breeding or draft work prior to slaughter. If found suitable, they would be reoffered for sale. Most farmers, however, would be willing to purchase these animals only at a substantial discount because the review process cannot provide the detailed information about production characteristics that they need. Such programs would incur large costs and operate at a loss. The opportunity for corruption would be substantial. An acceptable alternative, however, might be public agency pregnancy testing (or its training) for breeding animals so that owners could at least have this knowledge before deciding to slaughter. This effort would improve the market's operation, not impede it.

In summary, an observed herd decline is probably not related to higher beef prices, but to such other factors as higher maintenance costs, lower demand for draft, and rising animal productivity, which are occurring concurrently with the rising beef prices. Because the higher beef prices are more obvious, they mistakenly are attributed as the causal factor. Slaughter prohibitions, mistakenly used to reduce slaughter, will reduce livestock profitability, livestock use, and farm incomes. They may also reduce agricultural output. As shown in a previous section, over some range, higher beef prices should expand both beef and draft power output; the two outputs are then complementary, not rival.

The two outputs do become rival at some beef price and higher beef prices will then reduce draft

use, reducing the supply of grains. Beef cattle also may directly compete with grain supplies if land is diverted to fodder or animals fed concentrates. To the extent that such resource allocation accurately reflects consumer preferences, there is no reason to offset it. However, if the government wishes to reduce beef consumption and/or increase grain consumption, the optimal policies are either a tax on the price of beef or a subsidy to the production of grain. These achieve the desired goal at much less economic cost than does a slaughter prohibition.

Acknowledgment

I am grateful to John De Boer for referring me to numerous empirical studies on Asian livestock production, and to the conference participants especially T. Panayotou for helpful comments on the original version. Panayotou and Tokrisna (this volume) have written a similar and very interesting paper analyzing Thai livestock developments.

Livestock in Bangladesh: Present Situation and Future Research

Ekramul Ahsan[1]

Abstract. Livestock play a crucial role in the agricultural production systems in Bangladesh. For the subsistence farm economy, livestock is an essential component. Livestock provide the basic draft power for agricultural practices, organic manures for cropland, transport in both rural and urban areas, and are the main source of protein for human consumption. Livestock are also important sources of farmers' cash income, and in the national economy livestock bring a significant portion of foreign exchange earnings through the export of hides. Average annual per-capita meat consumption is quite low (1.96 kg/person), most of which comes from cattle (1.25 kg). Estimated total quantity of milk available for human consumption is about 900 000 t/year, and only 12 eggs are available per person per year.

The cattle and buffalo population is about 21 million of which 20.5 million are cattle. The cattle and buffalo are of indigenous types. Production of milk is only 3 kg/day and as work animals average bullock power is only equivalent to 2.26 kW. There are indications of a scarcity of draft animals. Insufficiency of feed and fodder as well as the lack of adequate veterinary services mainly contribute to this poor condition. Livestock as a whole provide about 200 000 t of fertilizer equivalent of organic manure annually. Livestock has been a neglected area of agricultural research in Bangladesh. Research efforts have been highly fragmented and uncoordinated. The Bangladesh Agricultural Research Council recently initiated a program to upgrade the quality of research and the skills for livestock research.

Résumé. Les bestiaux jouent un rôle essentiel dans les régimes de production agricole du Bangla Desh. Ils sont l'élément primordial d'une économie agricole de subsistance. Les bestiaux fournissent la force motrice et de traction principale pour les travaux agricoles, le fumier nécessaire aux récoltes, un mode de transport dans les régions rurales et urbaines ; ils sont aussi une source majeure de protéines pour l'alimentation humaine et une ressource financière importante pour l'agriculture et l'économie nationale. Les bestiaux constituent une proportion considérable des revenus en devises étrangères grâce aux cuirs et peaux exportés. La consommation annuelle de viande par tête est, en moyenne, très faible (1,96 kg/personne). La plus grande partie provient des bestiaux (1,25 kg). Le total estimatif du lait offert à la consommation humaine est d'environ 900 000 t/an, et la population ne consomme que 12 œufs par tête, annuellement.

L'effectif des bestiaux et des buffles représente quelque 21 millions de têtes, dont 20,5 millions de bestiaux. Ceux-ci, comme les buffles, sont indigènes. Le rendement en lait n'est que de 3 kg/jour et, comme animal de travail, le buffle moyen ne représente environ que 2,26 kW. On relève divers indices d'une pénurie de bêtes de trait. Cette situation peu brillante est surtout attribuable à une insuffisance de fourrages et de provendes et au manque de services vétérinaires adéquats. Globalement, les bestiaux produisent annuellement à peu près l'équivalent de 200 000 t d'engrais chimiques en fumier. Ce secteur de l'agriculture du Bangla Desh a été l'un des plus négligés par la recherche, dont les efforts ont été jusqu'ici fragmentaires et sans coordination. Le Conseil de la recherche agricole du Bangla Desh a, depuis peu, mis en œuvre un plan visant à améliorer la qualité de la recherche sur les bestiaux.

The economy of Bangladesh is based primarily on agriculture, and livestock is an essential component of the rural economy and the livelihood of the subsistence farmers. Livestock provide draft power for farm practices including plowing and threshing, organic manure for cropland, transport in rural and urban areas, and are the main source of protein for human consumption through the supply of meat, milk, and eggs. To the farmers, livestock are a source of income through the sale of live animals and animal products. In the national economy, livestock contribute significantly as an important source of foreign exchange earnings through the export of hides and skins, which accounted for about 13% of

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the total foreign exchange earnings in 1979. The contribution to the gross domestic product (GDP) by the livestock sector was 6.5% at 1980 market prices.

The average annual per-capita meat supply in Bangladesh is quite low (1.96 kg/person) (World Bank 1981). The major portion of this meat comes from cattle (1.25 kg/person) followed by poultry (0.45 kg/person), goats (0.23 kg/person), buffalo (0.02 kg/person), and sheep (0.01 kg/person). However, annual per-capita meat consumption reported in the 1975/76 household expenditure survey was 1.95 kg, and the 1975/76 nutrition survey of rural Bangladesh reported 1.39 kg. Although the highest figures for meat consumption are in the urban areas and the nutrition survey of rural Bangladesh is based on rural samples, the average meat consumption is likely to be lower in the rural areas than the overall average level of consumption in the rural and urban areas combined. Adequate data on milk and milk product consumption levels are not available, but based on the 1977 Bangladesh Agricultural Census data the gross annual milk production has been estimated as follows: cows, 2×10^6 t/year and buffalo, 0.06×10^6 t/year. (The contribution of goat milk was considered insignificant.) Of this amount, deducting about 55–60% for use by calves, the estimated total quantity of milk available for human consumption is 0.9×10^6 t/year. Based on World Bank figures, the availability of eggs (including chicken and duck eggs) amounts to about 12 eggs/person/year.

Characteristics of Livestock Population

According to the 1977 Agricultural Census there were 20.5 million head of cattle and 469 000 buffalo in Bangladesh. The cattle in Bangladesh in general are indigenous (*Bos indicus*). There are three varieties of indigenous cattle: large Deshi, small Deshi, and Red Chittagong. The productivity of these animals is quite low as is their working efficiency, and the average milk yield is not more than 3 kg/day. As work animals, the average bullock power is only equivalent to 2.26 kW. Buffalo are also a major source of draft power and milk, however, these animals are relatively small in size. Although buffalo are better work animals and produce more milk, their use is not as widespread as cattle.

The general health of the cattle and buffalo is poor. This condition is mainly attributed to insufficient feed and fodder. Under the present socioeconomic conditions and the paucity of agricultural land, farmers are more inclined toward cultivating crops on their available land rather than using it for grazing or pasture. Fodder cultivation is practically nonexistent. Moreover, due to competition for land by different crops, the trend is against using land for livestock feed and fodder. Veterinary services are also inadequate even for the basic prevention of diseases. In Bangladesh, the estimated density of cattle is not very favourable either. The arable land per animal is also poor compared with other countries. For example, Bangladesh has 0.46 ha/animal compared with 3.26 ha/animal in Thailand, according to figures from the International Bank for Reconstruction and Development (IBRD) for Bangladesh and the Food and Agriculture Organization of the United Nations (FAO) Production Yearbook for 1979 for Thailand.

Distribution of Cattle and Buffalo

Table 1 shows the distribution of cattle and buffalo in Bangladesh. A relatively large number of cattle are distributed in the districts of Rangpur, Mymensingh, Dacca, Rajshahi, Comilla, Khulna, Jessore, Dinajpur, Faridpur, and Barisal; however, these districts are also larger in area. It is interesting to note that the number of cattle per unit area is not significantly different between different districts, although the total average number of cattle per unit area in Bangladesh is only 0.9. Buffalo are concentrated in the coastal areas, i.e., in Patuakhali, Barisal, and Khulna, as well as Dinajpur, Rajshahi, Rangpur, and Sylhet.

Relatively more cattle are owned by small farms (Table 1). The average number of cattle per acre (1 acre = 0.40 ha) of farmland for small farms (0.5–1.5 acres) is 1.7 compared with only 0.6 animals per acre for large farms (over 7.5 acres). According to the 1977 Agricultural Census, about 9% of all livestock holdings have no cropland. The 1977 Agricultural Census also reveals that ownership of the total 20.5 million cattle is distributed as follows: 1–2 head of cattle is owned by 2.60 million farmers, 3–4 by 1.85 million, 5–9 by 1.17 million, and 10 or more head by 0.19 million farmers (for a total of 5.81 million farmers).

Livestock and Agriculture

Use of animal power is essential for land preparation (plowing, laddering), weed control (raking), threshing, crushing, and hauling. About 30% of total input costs for the cultivation of major crops is accountable by animal power. Land preparation is the most important function performed by bullock/buffalo in the majority of farms. Only 0.2% of all farmers use power tillers and only 0.6% of all farmers use

Table 1. Bangladesh livestock population (numbers/acre) by district and farm size, 1977.[a]

District	Farm size (acres)				Overall average
	0.5–1.5	1.5–2.5	2.5–7.5	>7.5	
Barisal	1.3	1.0	0.8	0.5	0.8
Bogra	1.7	1.3	2.0	0.25	1.0
Chittagong	2.2	1.5	1.0	0.5	1.3
Chittagong Hill Tracts	1.4	1.0	0.7	0.5	0.7
Comilla	1.5	1.2	0.9	0.6	1.0
Dacca	1.7	1.3	0.9	0.6	1.0
Dinajpur	2.0	1.4	0.9	0.6	0.9
Faridpur	1.4	1.0	0.8	0.5	0.8
Jamalpur	3.0	1.0	0.7	0.5	0.7
Jessore	1.6	1.2	0.8	0.6	0.9
Khulna	2.4	1.5	1.0	0.7	1.0
Kushtia	0.8	1.1	0.7	0.5	0.8
Mymensingh	1.6	1.2	0.9	0.6	0.9
Noakhali	1.3	1.0	0.7	0.5	0.8
Pabna	1.7	1.4	0.9	0.6	1.0
Patuakhali	2.4	1.4	0.8	0.5	0.7
Rajshahi	1.6	1.2	0.8	0.5	0.8
Rangpur	1.7	1.3	1.0	0.7	1.0
Sylhet	1.9	1.3	1.0	0.6	1.0
Tangail	1.8	1.4	0.9	0.6	1.0
Bangladesh average	1.7	1.3	0.9	0.6	0.9

[a]One acre = 0.40 hectares.
Source: Bangladesh Bureau of Statistics, Agricultural Census, 1977.

tractors (1977 Agricultural Census). On average 1 acre of land requires 2.5–3 days work by one pair of bullock. Therefore, for the total cropped area of 31.23 million acres in Bangladesh, over 1 billion days of animal labour (bullock) are required for land preparation (estimating that cropped areas are plowed six times). The total number of animals available for this work has been estimated as follows: bullocks, 7.61 million; working cows, 3.32 million; and buffalo, 0.32 million. Because cows are only capable of about one-half the bullock capacity, the total draft power available can be converted by comparing the number of work cows with bullocks: bullocks, 7.61 million; working cows, 1.66 million (bullock equivalent); and buffalo, 0.31 million, for a total of 9.58 million. Therefore, each of these animals has to work for almost 108 days to completely plow the total cropped area, assuming that the animals work every day and are not used for other purposes, such as hauling and crushing (sugarcane, oilseeds, etc.), which account for about 30% of total labour use in rural Bangladesh.

In view of the above, it is evident that work animals are scarce in Bangladesh, and they are a vital economic component of the agricultural production system. The situation was reviewed in a workshop on appropriate agricultural technology held in Bangladesh (BARC 1975) that recognized that for a long time to come, animal power would continue as the major source of draft required for different farm operations. Besides being an essential source of draft power for agricultural production, livestock also have a significant role in crop production through the supply of dung, which is used as manure. Estimated fresh dung production is as follows: cattle, 72×10^6 t; and buffalo, 2.8×10^6 t, for a total of 74.8×10^6 t (equivalent to 20×10^6 t of dry dung). It is estimated that about 10×10^6 t of dry dung is used as organic fertilizer. Each tonne of dry dung provides about 20 kg of chemical fertilizer in nutrient content, 10×10^6 t of dry dung represents a supply of 200 000 t/year of chemical fertilizers (World Bank 1981).

Research and Development

Livestock, in spite of its importance, has been a neglected area of agricultural research in Bangladesh. No visible improvement can be made because of the absence of a sense of urgency and low investment in research (BARC 1979). A survey of agricultural research in Bangladesh revealed that the livestock sector received only 1.03% of the total research funds in 1976–77. The technical manpower availability and the livestock sector both appeared to be very weak. According to the 1978 Agricultural Research Inventory, only 2% of the total technical

personnel engaged in agricultural research concentrated on the livestock sector.

In Bangladesh, research concerning livestock is highly fragmented and lacks coordination, but research on various aspects of livestock is currently being undertaken at several institutes: Livestock Research Centre; Dacca; Leather Research Institute, Dacca; Bangladesh Council for Scientific and Industrial Research, Dacca; Bangladesh Agricultural Research Council (BARC), Dacca; Bangladesh Rice Research Institute (BRRI), Dacca; Bangladesh Agricultural University, Mymensingh; Savar Dairy Farm, Dacca; and a number of voluntary agencies. However, the research lacks relevance and does not focus on the problems of the village economy (World Bank 1981). Research is currently under way in the agricultural economics and social sciences programs of BARC to identify the immediate problems of the rural livestock economy. Although priority areas for socioeconomic research on livestock have not yet been identified, some of the initial activities should concentrate on understanding the status of the livestock population in Bangladesh and its quality in terms of nutrition and health and how it relates to the draft power needed to support agriculture. Such information will help in formulating a strategy to increase meat and milk production. Other socioeconomic priority research areas should include the determination of an economically attainable level of livestock production to identify socioeconomic constraints that must be overcome to attain a higher level of production. Livestock production in this context includes both meat and milk production as well as draft power. Research should also include an analysis of the farmer's reasons for investing in livestock within the context of total farming systems.

This paper has attempted to focus on the status of cattle and buffalo in Bangladesh to draw to the attention of policymakers the necessity of developing the livestock sector for the betterment of the agricultural economy of the country. The strategy for upgrading the quality of research and skill in this area is being given top priority by BARC through the development of research facilities, scientific and technical manpower, and providing operational funds for research.

Among the specific research areas are:

- A survey of the livestock population in Bangladesh to identify characteristics of different livestock systems (traditional and modern livestock farming systems) and to help in understanding the characteristics of different subsystems of livestock production, namely dairy production, beef production, and draft power aspects;
- Determination of an economically attainable level of livestock production and identification of socioeconomic constraints to attain a higher level of production; and
- Analysis of the factors affecting decision-making when investing in livestock within the socioeconomic condition as well as within the context of total farming systems.

Aspects of the Cattle Economy in South Sulawesi, Indonesia

Kustiah Kristanto[1]

Abstract. Cattle raising is a good investment in the rural economy of South Sulawesi: as a consumer good, for milk production, for draft power and manure, and for its value as breeding stock. However, there is concern that farmers will not be able to meet the rising demand for cattle, or for livestock in general. To some extent one can account for this lack of response by the investment behaviour of livestock farmers, which in turn plays an important role in shaping the present cattle-holding and management system. This investment behaviour affects the size and the composition of cattle holding with respect to age and sex. All these factors will in turn influence the future development of the cattle industry and the success of policies to foster livestock development.

Résumé. L'élevage des bovins constitue une spéculation avantageuse dans l'économie rurale du Sulawesi-sud, à la fois comme produit de consommation, producteur de lait et de fumier et comme force de traction et cheptel de reproduction. On craint cependant que les cultivateurs ne puissent répondre à la demande croissante de bovins ou de bestiaux en général. Leur manque d'intérêt peut se justifier dans une certaine mesure par l'attitude des cultivateurs producteurs de bestiaux dans la disposition de leur argent, attitude qui, à son tour, joue un rôle important dans la constitution du régime actuel de tenure et d'élevage du bétail et se répercute ensuite sur l'importance et la composition des troupeaux d'après l'âge et le sexe. Ensemble, ces facteurs influenceront le développement futur de l'industrie des bovins et le succès des politiques visant à développer l'élevage des bestiaux.

The cattle sector is an important part of the Indonesian rural economy. About 13% of Indonesia's smallholders, who account for 60% of the total population, are engaged in cattle raising and crop cultivation (1973 Agricultural Census). To the smallholder cattle raising is a good investment; as a consumer good, for milk production, for draft power and manure, and for its value as breeding stock. However, there is concern that farmers will not be able to meet the rising demand for cattle, or for livestock in general, and that it will be necessary to import meat and milk, for example, if domestic production is not increased.

The problem of evaluating investment in livestock in relation to its various functions has not been adequately covered. This investment opportunity plays an important role in shaping the present livestock economy in South Sulawesi. Therefore, an examination will be made of the role of investment in livestock and the need to consider this role in developing livestock programs in South Sulawesi.

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Indonesian Livestock Economy

Size and Distribution of Stock

Indonesia's livestock population in 1976, the most recent period for which data are available, was about 8.6 million of which about 6.2 million were cattle; roughly 41 head of cattle for every 100 ha of arable land. As may be expected, the distribution and, hence, the density of the cattle population, varies widely among the provinces (Table 1). Java has about 61% of the total cattle population. The provinces with the greatest number of stock are East Java, Central Java, South Sulawesi, East Nusa Tenggara Timor, and Bali, and the provinces with the fewest livestock are West Kalimantan, Southeast Sulawesi, Lampung, and South Sumatra.

The overall density of the cattle population relative to agricultural land ranges from 6/100 ha in West Kalimantan to 136/100 ha in Bali. In general, and relative to cropped area, provinces with a relatively high density of human population also tend to have a high density of cattle population. Because a high percentage of the human population lives in the rural

Table 1. Human and cattle population relative to agricultural land and farm.

Provinces	Population density per 100 ha of agricultural land	Total cattle population ('00)	Cattle density			
			Per 1000 population	Per 100 ha of agricultural land	Per 100 ha of farm agricultural land	Per farm
Aceh	362	1676	72	26	45	0.47
North Sumatra	478	1315	17	9	16	0.16
West Sumatra	798	1406	46	36	41	0.33
South Sumatra	549	834	21	12	12	0.22
Lampung	421	743	21	9	11	0.17
West Java	1296	1297	5	7	9	0.05
Central Java	1285	10258	43	55	59	0.37
Jogyakarta	1412	1878	71	100	104	0.55
East Java	1189	24385	89	106	120	0.79
Bali	868	3672	156	136	88	1.20
West Nusa Tenggara Berat	825	1385	56	46	48	0.49
East Nusa Tenggara Timor	382	4030	161	61	62	1.10
West Kalimantan	231	556	24	6	6	0.02
South Kalimantan	614	241	13	8	9	0.09
North Sulawesi	526	1461	75	40	42	0.67
Central Sulawesi	376	1181	110	41	42	0.89
South Sulawesi	707	4913	82	58	67	0.75
Southeast Sulawesi	517	110	14	7	7	0.11

Source: Agricultural Census, 1973 and Statistical Pocketbook of Indonesia, Biro Pusat Statistik, 1977/78.

areas, this pattern reflects the use of cattle for draft purposes.

Cattle density does not increase in the same proportion as human population density. In fact, the rate of increase in cattle density tends to decline as the human population rises, suggesting that as the human population increases more land will be used for crop cultivation, or existing rice fields will be cultivated more intensively, leaving less land for cattle raising. Another possible explanation is that more cattle are consumed for beef as population increases.

Livestock holdings also vary according to farm size; on holdings of less than 0.5 ha, about 10% of the farms own cattle (or buffalo); on farms of 0.5–2 ha the animal ownership rate rises to about 29.5%, and on farms of more than 2 ha it rises to about 43.4%.

There is some difference of opinion concerning the trend in cattle population. The 1980 report on cattle smallholders made by the World Bank (1980, p.7) indicates that cattle numbers increased by about 1%/year from 1976. However, annual statistics for 1976 on livestock published by Biro Pusat Statistik, state that the total cattle population has actually declined over the last 10 years by about 11% or 1.2%/year. The possible reasons for this trend are the growing population density, labour becoming relatively cheaper, and the growing demand for meat.

As indicated by the 1963 and 1973 Agricultural Census, the cultivated area per farm on holdings of less than 0.59 ha has declined from 0.55 ha in 1963 to about 0.26 ha in 1973, and on farms of more than 2 ha it has declined from 4.22 ha to about 0.92 ha. In view of the positive correlation between size of cultivated land and cattle holding, these data explain the downward trend in Java where the majority of farms are less than 0.5 ha. The cattle population of East Java and Central Java, which contributes about 55% of the national herd, has declined over the past 10 years by about 20 and 15%, respectively.

Another possible explanation is that declining farm size is causing a shift from animal to human labour in paddy cultivation (either family labour or cheap labour, which is expected to increase as the cultivated area per farm declines). Under these circumstances when a farmer needs cash, female cattle not urgently needed for draft are sold and a proportion of these is slaughtered. It is estimated that in East Java about 30% of productive female cattle sold are slaughtered (FAO/World Bank 1979, p. 4).

Other factors are steadily increasing incomes and a growing demand for beef in urban areas, which is reflected by an increase of 22% from 1968 to 1976 in the registered livestock slaughtered annually. The increase in the unregistered livestock slaughter is about 5%/year (FAO/World Bank 1979).

The downward cattle-holding trend in East and Central Java is partially offset by the upward trend in the other three major cattle-producing provinces of South Sulawesi, Nusa Tenggara Timor, and Bali.

In these provinces, the size of the cattle population has risen over the past 10 years by about 112, 30, and 19%, respectively.

Investment in Cattle in South Sulawesi

The basic problem in the agriculture of South Sulawesi is not the average size of holdings (1.14 ha) or population density (707 people per 100 ha) compared for instance with Java (Central Java 0.63 ha and 1285 people per 100 ha and East Java with 0.66 ha and 1189 people per 100 ha). However, of the total land area that has been surveyed in South Sulawesi, about 9.1% is unirrigated rice land, 0.3% is estate land, 10.6% is dry land, 48% is shifting cultivation, 10.8% is pasture, 13% is forest area, and only 3.3% is irrigated rice land. Consequently, farmers generally operate either one kind or a combination of unirrigated rice land, irrigated rice land, and dry land, on which they could grow paddy, corn, cassava, peanuts, and raise cattle.

South Sulawesi ranks third among Indonesia's provinces in the number of cattle produced, fourth both in the density of cattle per population and per farm and seventh in the density of cattle per agricultural land (Table 1). Furthermore, only Nusa Tenggara Timor is ahead of South Sulawesi in the total number of farms that also raise cattle (1973 Agricultural Census).

The small cattle holder is the backbone of cattle raising in South Sulawesi with more than 90% of all cattle in this province maintained on smallholdings. Under traditional management, they fill a multiplicity of functions as consumer goods, as intermediate goods and services, and as breeding stock. Cattle raising provides cash income to the farmers, particularly in the dry areas. For example, Sidenreng-Rappang is an area dominated by irrigated rice fields with a smaller portion of rain-fed rice fields and dry fields, whereas Gowa features mainly unirrigated rice fields and dry fields. In Gowa, the contribution of cattle to farm income is relatively more important than in Sidenreng-Rappang, and in the unirrigated part of both Sidenreng-Rappang and Gowa, almost 50% of farm income is derived from cattle enterprises.

From 1968 to 1976, of the five major cattle producers in Indonesia, which account for 76% of the cattle, only South Sulawesi showed a favourable growth trend. This trend could be explained by the fact that from 1923, the year that Bali cattle (*Bos sondaicus*) was first introduced by the Dutch government into South Sulawesi, up to 1968, when exports and interisland trading began, the number of cattle was continually multiplying, with only a small number of cattle being slaughtered for local consumption and hardly any exported from the province.

There is a strong indication, however, that with steadily increasing local demand for beef (6%/year) and interisland cattle trading (10%/year) and unchanged patterns of cattle holding and management, the trend in South Sulawesi will soon follow that of Nusa Tenggara Timor and Bali and possibly even follow the decline in East Java and Central Java (Tables 2 and 3).

Table 2. Estimated supply of cattle and buffalo in South Sulawesi, 1973–85.

Year	Number of cattle and buffalo	Increase	Local consumption	Marketing supply	Export and interisland trading	Surplus or deficit
1973	758679	115005	91181	23824	16330	7494
1974	766173	133773	97107	36666	18686	17980
1975	784153	136913	103419	33494	18686	14808
1976	798961	139498	110142	—	—	29356
1977	828317	144624	117301	—	—	27323
1978	855640	149394	124925	—	—	24469
1979	880109	153667	133046	—	—	20621
1980	900730	157267	141694	—	—	15573
1981	916303	159986	150904	—	—	9082
1982	925385	161572	160712	—	—	860
1983	926245	161722	171159	—	—	−9437
1984	916808	160074	182284	—	—	−22210
1985	894598	156196	194132	—	—	−37935

Note: The number of buffalo in 1973, 1974, and 1975/76 were, respectively, 37, 46, and 44% of the total.
Source: Mubyarto et al. (1976, p. 23).

Table 3. Interisland trading of livestock in South Sulawesi.

Year	Cattle	Buffalo
1968	635	211
1969	3316	389
1970	7490	1531
1971	8504	788
1972	8066	1398
1973	8621	1253
1974	11958	2425
1975	10269	4224

Source: Annual Report on Livestock in South Sulawesi, 1974, 1975/76, and 1977/78.

As shown in Table 2, Mubyarto et al. (1976) projected a decline in livestock population by 1984, because as of 1983 the natural increase will no longer be sufficient to meet local consumption needs. The tendency has been to look at the growth of the cattle population as being governed by natural factors rather than economic considerations.

To what extent do economic considerations affect the pattern of cattle holding and its management system? Several researchers suggested that the pattern of livestock ownership and management is responsive to economic forces operating within existing institutional constraints. Mishra (1970) has suggested that the secular trends in the decelerating growth of the cattle population and an increasing specialization in the use of cattle for work or milk reflects adaptations to economic forces. Vaidyanathan (1978) has noted that the variations in composition of cattle herds among regions in India apparently relates to the economic needs of their respective human populations. Raj (1969) states that holdings of livestock in any economy are adjusted to the needs of the human population. A change in per-capita consumption or income or in the techniques of land cultivation (plowing) will affect the sex and age composition as well as the size of the livestock holdings.

In India, when cattle are required for traction purposes and grazing land is limited, there would be a tendency to slaughter them for beef or to sell them for cash but only at a fairly advanced age when they can no longer perform their function as intermediate goods or be used for breeding purposes. This was the case in Europe in the 17th century and in Indonesia at present where livestock are disposed of at the average age of more than 10 years (Tillman 1975).

Raj suggested that where incomes are relatively high there will be a higher proportion of adult cattle and bulls, machines will be replacing animal power for traction, and the demand for livestock is primarily to satisfy beef, dairy, and breeding requirements. In support of this view, Raj compared the composition of the cattle herd in India and the U.S. (Table 4). India has an economy where income is relatively low and animal power is used for plowing. The U.S. has a high income economy where machines have replaced animal power for traction and the demand for livestock is primarily for beef and milk. In India, a relatively high proportion of male cattle must be used because metal plows and harrows, which are much harder to work than wooden tools, are widely used. Apart from plowing, cattle in India are also maintained for well irrigation and pulling carts. There is a marked difference between the proportion of male cattle in India, 68.2%, compared with that in the U.S., 19.4%. However, the proportion of calves maintained in the U.S. was very high compared with India (equivalent to 73% of the adult cattle population). This reflects a livestock demand mainly for beef with practically none for traction purposes.

In view of the similarities between India and South Sulawesi in level of income, technology of traction, and low consumer preference for beef (consumption in South Sulawesi is relatively low compared with Java and some parts of Sumatra), we would expect to find a similar pattern of cattle holding in South Sulawesi. If there were differences in the technology used in farming, for example, in South Sulawesi wooden plows and harrows are still used in contrast to metal plows in India, this should again be reflected in the composition of the herd.

Table 4. Composition of cattle holding in India (1956) and the United States (1958).

	Number ('000)	Adult cattle (%)
India		
Cows required for milk	31.91	31.8
Bulls required for work	68.43	68.2
Adult cattle	100.34	100.0
Total cattle population	226.77	
United States		
Cows and heifers 2 years and older		
Kept for milk	22.36	38.5
Kept for beef	24.43	42.1
Total adult female cattle	46.79	80.6
Steers 1 year and older	9.51	16.4
Bulls	1.66	3.0
Total adult male cattle	11.17	19.4
Total adult cattle	57.96	100.0
Total cattle population	100.00	

Source: Raj (1969, p. 66).

Cattle Holding in South Sulawesi

Except for the 1967 Survey and Livestock Inventory and the 1976 Agricultural Survey, there are no recent data available on the age and sex composition of livestock in Indonesia. Table 5 shows the pattern of cattle holding in South Sulawesi based on these surveys. From these surveys and interviews conducted by the author with 200 farmers in Bone and Pinrang, two regencies in South Sulawesi, it appears that there were only slight changes in the composition of cattle holding over the past 10 years. Rollinson and Nell (1973, p. 19), also reported the proportion of male cattle to be about 22% of the total cattle population. The data illustrate the use of cattle primarily as draft animals. The ratio of male cattle to adult cattle is much lower in South Sulawesi than in India, and it is similar to the ratio in the U.S. As mentioned previously, wooden plows and harrows are widely used in South Sulawesi, and female cattle can be used. In Pinrang, not every smallholder even keeps male cattle, and in Bone only one on average.

The sex and age composition of the livestock herd will have an impact on the growth and development of the cattle population. The proportion of male to female cattle in South Sulawesi is considered too high and, thus, inefficient for breeding purposes. The most efficient ratio suggested by Rollinson and Nell (1973, p. 40) is around 7–7.5%. Thus, allowing a 10% ratio of male cattle to female cattle, there would be a surplus of male cattle of about 94 in Bone and 48 in Pinrang that could otherwise be replaced by breeding stock. This may reflect the fact that the use of female animals for traction purposes extends the calving period (Paggi 1975, p. 2). However, female cattle are important as a source of food, for breeding, and for their store of value as an asset.

In a rural economy, where the majority of farmers have very limited cash flows, this type of saving can be done without having to put aside some production. For the farmer who has no individual title to land it is also the most accessible and reliable vehicle for the accumulation of wealth (Doran et al. 1979, p. 45). It will enable farmers to accumulate gradually agricultural surplus and expand their farm operation. However, the value of cattle as an asset is also a function of the cost of labour needed to maintain them. Without the use of labour, their value as economic goods may suddenly decline or disappear altogether. Therefore, the number of cattle that can be raised by smallholders will be influenced by the availability of family or hired labour.

Although the productivity of livestock as beef cattle is related to the quantity and quality of feed, its productivity as draft cattle is less dependent on feed, particularly in terms of traction requirements of farmers with relatively small holdings. Draft animals are required for plowing for only a limited number of weeks in the year and, except for this period, the farmer does not have to be as much concerned with the quality or quantity of feed as at other periods.

The same situation is true for breeding cattle or beef cattle. When large markets for beef cattle are not open to livestock holders they have only their own household or village demands to satisfy. The smaller the holdings of land and the lower the standard of consumption of the farmers the smaller will be the demand and the higher the cost of feeding them if feed has to be purchased. However, it might still pay to have a few animals around as a form of saving so the farmers can sell them when the demand occurs, but only if the costs of raising them are very small (i.e., it does not exceed the value of the increase in their weight and calves over the year).

Table 5. Composition of cattle holding in South Sulawesi, Pinrang, and Bone.

	South Sulawesi		Pinrang	Bone
	1967	1976	1976	1976
Adult cattle				
Female	133800	369341	417	343
Male	41100	126485	90	128
Total	174900	495826	507	471
Percentage male in total	23	26	18	27
Young cattle (1–2.5 years)				
Female	40800	82944	—	—
Male	22800	53661	—	—
Total	63600		—	—
Percentage male in total	36	39	—	—
Calves (<1 year)	61200	134152	215	141
Percentage of calves to adult cattle	35	27	43	30

Source: Survey and Livestock Inventory, 1967 and Agricultural Survey, 1976.

In South Sulawesi, where the care of cattle is confined to tending grazing herds on the grassland around the village, this task is performed primarily by children and women. The necessity to limit costs also accounts for the restriction on the amount of feed given to the cattle. However, the employment of child labour brings some consequences to the growth of the cattle population. For example, the increasing opportunities for children to receive free education in the primary schools and the widespread introduction of "inpress" schools will restrict the number of animals a smallholder can keep. The majority of smallholders interviewed had to restrict the size of their holdings for this reason. (Adult labour could not be used as a substitute for child labour because tending animals is considered to be an inferior occupation for adult males in the Buginese and Makassar society.) There would, therefore, be an upper limit to the number of animals that can be maintained by smallholders; the limiting factors being the availability of grazing land and child labour. Another problem in using child labour is their lack of experience in detecting livestock diseases. Early detection of some of these diseases would prevent animal losses but as to what extent requires further study.

Management System

Livestock smallholdings in Indonesia are largely managed in simple and traditional ways. During the crop-growing seasons cattle are tethered for grazing on roadsides or herded in nearby uncultivated arable land. Feed supplements in the form of crop residues, cut grasses, or concentrates, are seldom given. It is not surprising, therefore, that inadequate nutrition has been suggested as the single most important constraint on cattle production, but this should be affirmed through deeper investigation.

The way in which the smallholders choose to feed their cattle reflects the fact that cattle are demanded as an intermediate good, namely as animal power for usually 30–45 days in one cropping period. Except for this period in which the animal is given supplementary feedings of cut grasses, rice bran, and salt, the farmer does not have to be very concerned with the quality or quantity of feed the animal receives but only with meeting its needs for survival. Thus, during their unproductive period, it does not pay for the farmer to incur additional costs either in the form of additional labour time or in cash outlay for feed supplements. Most probably, either the increase in the value of the animal over a year is a poor return for the work involved as compared to devoting the time to peddling or some other off-farm jobs or the marginal costs are greater than the marginal revenues contributed by cattle over a year.

Regarding the behaviour of farmers toward the management of their livestock, Firth (1964, p. 21) states: "Failure to maintain new types of equipment properly is usually due to lack of proper training. . . to lack of full employment for the equipment, which can lead to neglect; or to lack of cash to pay for running repairs." Firth's argument, it seems, is also relevant to livestock as capital goods. As in the case of mechanical equipment, i.e., tractors, livestock are assets that are productive only during a limited period in the year when they are actually being used. When they are not working on the field, and are, therefore, not productive, the farmers are not very much concerned with the nutritional condition of the cattle. The same reasoning is used when considering cattle as a store of wealth. The farmers' concern is to keep the costs of maintaining the animals as low as possible but enough to ensure that their value is not reduced by injury, disease, or death.

Overgrazing in some traditional areas in South Sulawesi has also been attributed to the factors mentioned above. There is about 1.5 million ha of available land with a carrying capacity of about 1.5 million livestock. This figure includes 590 000 ha of pasture, 585 000 ha of shifting cultivation, and 345 000 ha reserved as forest. With the present cattle and buffalo population at about 900 000, there seems to be sufficient area for livestock expansion. The problem, however, lies in the uneven distribution of land in terms of livestock and human population. Such high density areas as Barru, Soppeng, Wajo, and Bone have a high cattle population density (Table 6). Much available grazing land, however, is available in Majene, Mamuju, and Luwu, which are residencies with very low population densities of 48, 7, and 17/km^2, respectively. A similar pattern of cattle population and grazing land distribution is also found within residencies and districts (Table 7).

This distribution pattern puts a constraint on the development of the cattle population. In densely populated areas there will be a shortage of available grazing land within a short distance from the farmer's village. To acquire a reasonable quantity of feed, the animals must be driven to distant grass areas, watched while they feed, and then brought back at dusk. However, there is the risk of animal loss particularly when being cared for by children. Individual farmers seem to resolve the pressure of land and labour resources by maintaining a higher percentage of adult animals to the total cattle population by giving young cattle into the care of other farmers to be reared on an issue-sharing basis.

Table 6. Human and cattle population relative to land in South Sulawesi, 1978.

Residency	Dry field and house yard (ha)	Grassland (ha)	Population density per km²	Cattle density per 100 ha dry field and grassland
Maros	17287	11813	122	58.0
Pangkep	9202	4690	256	160.0
Gowa	35826	1929	193	31.0
Takalar	7367	1182	257	2.0
Selayar	17905	116	422	0.3
Jeneponto	27856	—	277	13.0
Bantaeng	15934	—	220	2.0
Bulukumba	89705	—	222	25.0
Sinjai	36817	8551	148	50.0
Bone	106244	12406	129	82.0
Soppeng	35015	19160	157	106.0
Wajo	60449	16943	152	42.0
Luwu	56849	44536	17	19.0
Tana Toraja	97927	—	74	0.5
Enrekang	24866	—	66	59.0
Sidrap	25997	10579	82	69.0
Barru	14028	7569	148	241.0
Polmas	67164	29605	34	15.0
Pinrang	55194	13130	107	39.0
Majene	10191	1310	48	3.0
Mamuju	19323	3515	7	5.0

Source: Statistical Report on Food Crops in the Province of South Sulawesi, 1978 and Annual Report, 1978.

Table 7. Human and cattle density in Bone and Pinrang, South Sulawesi, 1978.

District	Population/km²	Cattle/km²
Bone		
Tanete	1398	66
Awang Pone	251	67
Ajangale	322	9
Bontocani	51	6
Dua BoccoE	276	26
Kajuara	208	13
Kahu	100	20
Lamuru	51	0.2
Libureng	78	15
Ponre	50	3
Pallakka	260	82
Salomekko	113	17
Lapariaja	151	26
Barebbo	128	0.04
Sibulue	128	16
Cina	1105	0.003
Pinrang		
W. Sawitto	303	19
M. Bulu	137	26
Suppa	185	0.03
Matiro Sompe	300	0.04
Watang Panua	97	11
Duang Panua	94	0.06
Lembang	35	5

Policy Implications

It has been estimated by the Livestock Division of the Department of Agriculture that South Sulawesi requires about 2.5 million livestock (cattle and buffalo) for draft power, slaughter, and breeding. To meet this demand the government is developing the following programs:

- *Credit program to assist smallholders with the fattening of animals (Panca Usaha Ternak Potong)*: The smallholder is given a credit package that includes the purchase of one cow, feed, labour, health care, and a small yard. Repayment must be made within 6 months at an interest rate of 1.25%/month. It is assumed that this period is sufficient to produce a fattened animal and a reasonable profit. It has also been estimated that after three successful loans, a farmer should have accumulated sufficient private funds to buy one animal.

This program began in 1977, but because of a lack of smallholder involvement, the program was cancelled after 2 years. It seemed that a major reason for the lack of interest was that the program did not take into account two of the major reasons the smallholders have for keeping cattle, namely as a store of wealth and as a source of draft power. Also, farmers feel uncertain about their ability to repay the loan,

particularly in light of the small market for fattened cattle.

- *Credit program for breeding cattle (Panca Usaha Ternak Bibit)*: With this program farmers can have credit sufficient to buy five animals, erect a yard, and buy feed, medicine, and labour. At the end of 3 years the farmer must return three cattle, and another two cattle at the end of the 5th year. This program also began in 1977, and it has been very successful considering that all offers of credit have been accepted. One of the reasons for success is the flexibility to choose the technique of cattle raising and the uses to which the animal is put as breeding stock, as a draft animal or as a slaughter animal, or merely to increase the number of animals.
- *Rural miniranch:* As yet, only a pilot project has been implemented for the rural miniranch. This program is intended for those areas where the proportion of potential grazing land relative to cropping land is high (i.e., Kabupaten and Sidenreng-Rappang). The location and size (up to 50 ha) of a miniranch within the village will be decided by the regional government. The organization and the running of the ranch is the responsibility of the village community through the institute for cooperatives in the village. The smallholders who cooperate to form a ranch must contribute the cost of fencing, in money or kind, and the cost of established strips of improved grasses within each of the paddocks of fields within the ranch. It is envisaged that each ranch will contain four paddocks. These would be grazed on a rotational basis with the animals being removed to each farmer's own yard at night.

One of the objectives of this scheme is to increase the control over the animals, which would otherwise be free-ranging, as well as reducing the labour needed for cattle tending. Technical advice on matters such as animal health and pasture establishment and management will be provided by the government. This scheme offers the farmers freedom of choice over the disposal of cattle. Unlike the breeding program, it has the additional advantages of reducing labour requirements and the uncertainty of feed supplies. However, expertise is needed to establish and manage the improved grassland. Farmers must also be able to work together to manage the ranch. There is a need for extension services and close liaison between the farmers and the local government. Because of the opportunity for farmers to pursue their objectives in raising cattle and because it would resemble the traditional "*gotong royong*" method in raising cattle, the chances of this scheme being acceptable to farmers seem good.

- *Paddock intensive system:* In contrast to the miniranch, the paddock intensive system would involve those areas with a higher proportion of cropland to grazing. Under this scheme it is suggested that farmers could utilize the residues of both paddies and *palawija*. Farmers would be encouraged to feed harvested crop residues to penned animals. Advice to farmers on methods of harvesting and preserving the crop residues, feeding rates, supplementary rations, and health care will be provided free by the government. Some objectives of this scheme include the provision of feed during the growing period of the subsequent crop (a time of feed shortages for animals) and increasing the degree of control over animals. Even though the farmers are left to pursue their own objectives, the technique of hand-feeding animals and preserving crop residues is relatively untried in South Sulawesi. To this extent farmers' reactions to this scheme might be similar to the cattle fattening scheme, although there is an attempt to improve production without the risk associated with credit.

Conclusion

In this paper an effort has been made to assemble some of the available information on the nature of investment in livestock and its impact on shaping the present livestock economy in South Sulawesi. The existence of a systematic relationship between human density and the level and composition of the livestock herd and the factors influencing the acceptability of government livestock programs to smallholders are interesting findings. The attempt to explain these patterns is still too crude and simplified to provide reliable answers. They do, however, raise several questions that deserve to be pursued in greater depth to understand the factors determining the size and productivity of a resource that to smallholders is second in importance only to land. Among these is the need to evaluate the socioeconomic impacts of the various government livestock policies, projects, and research on the needs and priorities of the farmers.

The Economics of Two Major Dairy Systems in the Punjab, Pakistan

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Abstract. The role of livestock in the Punjab is discussed and two major livestock production zones, grassland and central irrigated, are defined. Based on two independent surveys, information on the structure of dairy production and the results of a gross margin analysis of two major dairy livestock systems in the Punjab are presented. Past cost of production studies are also reviewed. The present study demonstrates cash costs of Rs 1.70/L and Rs 0.60/L for milk produced under irrigated and semibarani conditions, respectively. Comparative economic costs are Rs 4.50/L and Rs 1.80/L. The implications of these costs are discussed and suggestions are given on the requirements for growth of the dairy sector.

Résumé. L'étude porte sur l'importance du bétail au Punjab et décrit deux importantes zones productrices, l'une en savane et l'autre, centrale, irriguée. Elle fournit, à partir de deux enquêtes indépendantes, des renseignements sur la structure de la production laitière et les résultats d'une analyse des marges brutes de deux types d'exploitation du bétail laitier au Punjab. On passe également en revue des analyses de coûts de production antérieurs. L'étude révèle des dépenses de Rs 1.70/L et Rs 0.60/L pour le lait produit, respectivement, en régions irriguées et semi-barani. Les coûts économiques comparés sont de Rs 4.50/L et de Rs 1.80/L. On discute ensuite des conséquences découlant de ces coûts et l'on soumet quelques suggestions concernant les exigences imposées par le développement du secteur laitier.

The low level of understanding of the importance of the livestock subsector in the Punjab, indeed in Pakistan, is reflected in the low proportion of Annual Development Programme (ADP) funds allocated to livestock. Despite livestock's 10% contribution to the national gross domestic product (GDP) and 28% contribution to total agricultural output, the livestock subsector received only 5% of the ADP funds in 1979–80 compared with the 38% received by the crop subsector. Also less than 20% of the Agricultural Research Council's funds were allocated to livestock research.

The generally low level of inputs into livestock is reflected in the growth performance of the subsector. Since 1960, the human population of Pakistan has increased by 52%, but the livestock population has grown by only 28%. Expressed in 1959–60 prices, livestock's contribution to GDP has fallen from 17.2% in 1960 to 10.6% in 1972 and an estimated 9% in 1980. Annual growth rates of the various populations were estimated at buffalo, 1.9%; cattle, 0.03%; goats, 10.7%; sheep, 10.8%; poultry, 15.0%; and others 2.1% for the period 1972–76 (Hussain 1981).

Until recently, virtually no economic research on livestock had been undertaken in the Punjab because of the emphasis on cash cropping and the lack of economists in the Department of Livestock and Dairy Development (DLDD). In this paper, the principal livestock zones of the Punjab are defined, recent cost of production work discussed, and economic priorities regarding livestock are suggested.

Livestock Production Zones in the Punjab

Of the two distinct livestock production zones in the Punjab, the barani (rainfed) areas of the Rawalpindi and Bahawalpur divisions make up the grassland zone. This zone has limited arable cropping and extensive livestock production systems, both migratory and static. The second zone, the central irrigated zone of the Punjab, is made up of the Sargodha,

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Lahore, and Multan divisions (Hussain 1981). The central irrigated zone is some 12×10^6 ha of which 82% is potentially cultivable.

Only 1% of the zone is forested and 17% (2×10^6 ha) of the land is not suitable for cultivation. The five rivers of the Punjab dominate the area and supply water to the irrigation canals that support intensive cash cropping activities. Split between north (Rawalpindi division) and south (Bahawalpur division) the grassland zone contains 4.8×10^6 ha of land of which 69% is potentially cultivable, 6% is in forest (mostly Rawalpindi), and 25% is not available for cultivation.

According to the latest official figures (1976 Livestock Census), there were almost 8 million buffalo in the Punjab in 1976. Of these, 3.8 million were milch animals. Just over 80% of the buffalo herd was located in the central irrigated zone. The buffalo population was increasing slowly with a small increase in the proportion of animals in the central irrigated zone. Of the cattle population, 71% were located in the central irrigated zone. Again the proportion of the cattle population was increasing in this zone despite a very small overall decrease in total population. The milch cattle population of 2 million animals had a higher proportion (33%) of its population in the grassland zone. The impact of mechanization was clearly demonstrated in the 35% reduction in work animals (mostly cattle) between 1960 and 1976. Of the sheep and goat populations, both demonstrated strong growth from 1960 to 1976. In that year, the sheep population was 8 million (22% grassland zone) and the goat population was 7.8 million (36% grassland zone).[3]

The provisional human population of the Punjab in 1981 was 47 million, of whom 67% were rural dwellers and 33% urban. The urban growth rate is estimated to be 4.4%/year — twice that of the rural areas (Hussain 1981). This trend is due largely to a substantial amount of rural–urban migration. Since 1972, the proportion of urban dwellers has increased from 24.4 to 32.9%. In the central irrigated zone where 76% of the Punjab population reside, 66% are rural people. In the grassland zone, 70% of the 11.3 million people live in rural areas. The population density in the grassland zone is 2.33 persons/ha and 8 persons/milch animal. The comparative figures for the central irrigated zone are 2.95 persons/ha and 8.01 persons/milch animal.

The steadily increasing livestock population in the central irrigated zone is placing greater demands on the feed resources of this area. Erosion in the grassland zone (Rawalpindi) and increasing areas of saline, alkaline, and water-logged soils in the central irrigated zone are reducing the amount of grazing land. The lower growth rate of the livestock population compared with human population growth rates, static or declining productivity per head, and a low proportion of development funds all contribute to a crisis situation for livestock in the Punjab.

Over the past 3 years, support by outside agencies has enabled both the DLDD and the Faisalabad University to initiate some research on livestock. The few cost of production studies undertaken have all focused on the dairy animal, because it has the greatest potential for increased livestock protein production in a situation of fodder scarcity.

Previous Cost of Dairy Production Studies

The first substantive study of dairy production costs reported by Jost (1980) was based on a survey of six villages in the central irrigated zone. Based on purchasing a 4-year, first-calving buffalo heifer and maintaining it until lactation was completed at the end of its 12th year, the direct cost of production was estimated to be Rs 2.03/L for an average lactation yield of 6.5 L/day (as of 1982, Rs 10.50 = U.S. $1.00). The cost of feeding made up 79% of the total direct costs. The total feed cost was estimated at the market rate for the various types of fodders. No account was taken of feed produced by the farmer or earned as a wage substitute. The cost had no labour component as only family labour was involved.

The case of landless dairy producers was presented by Aslam and Haider (1981). Production compared with Faisalabad City and a nearby village presented cost of production estimates of Rs 1.38/L (80% feed) and Rs 1.05/L (72% feed), respectively. These figures are estimates of the true cash cost of producing milk as the fodder costs were estimated on actual cash outlays for fodder paid for directly or by wage substitution. The lower cost was also influenced by the higher productivity of the animals (8.5 L/day during lactation) and the high proportion of the animals (75–80%) in milk. This high percentage of wet animals is a result of the city milk producers maintaining only wet animals in their herd, a practice that substantially affects the reported cost of production.

The Current Study

The study presented here estimates the type of costs incurred under the irrigated and semibarani dairy production systems. These were assessed on

[3]The livestock population statistics were derived from 1979 Develoment Statistics of the Punjab, Bureau of Statistics, Government of the Punjab, Lahore.

the basis of two independent surveys. The first, carried out by the Punjab Economic Research Institute (PERI) investigated the irrigated area of the village of Bohiwal (168 families), which is located near Lahore. This survey was part of a four-village survey conducted by PERI in association with the Agricultural Development Council (ADC). Undertaken in April and May of 1980, the survey team interviewed 40 land-holding farmers of whom 50% were predominantly (greater than 50%) tenants and 50% were predominantly (greater than 50%) landowners.

The survey of the semibarani (partially irrigated) production system was carried out by the Livestock Production Research Institute (LPRI) (a directorate of DLDD) and assisted by a team from the Food and Agriculture Organization of the United Nations (FAO). The field work for this study was undertaken in January and February of 1981 and involved 40 families (50% landowners and 50% tenants) of the total of 400 families in the village of Nama Jindeyka, near Haveli some 210 km from Lahore.

In the irrigated village, farm size was just over 2 ha of which 60–70% of the land was cultivable.[4] The average size of holding was greater on the less productive land of Nama Jindeyka. In both villages tenants had a higher land use intensity. Fodder crops played an important role in the cropping activities of both groups but there was a higher proportion of cropped area in the irrigated village. This difference was due to the lower amount of communal grazing available in Bohiwal. Despite the smaller size of holdings, both farmers and tenants in Bohiwal had close to 3 milch animals/household whereas in Nama Jindeyka the figure was just over 1.5 milch animals/household. Draft animals were relatively unimportant in Bohiwal, but in Nama Jindeyka farmers usually owned one draft animal and tenants a working pair. The ready access to Lahore, the major urban centre of the Punjab, was reflected in a higher level of commercialization among Bohiwal livestock owners. Market access was reflected in the higher volume (both absolute and in value terms) of livestock trading and in the greater proportion of liquid milk sold. A further indication of the importance of market access was the larger amount of ghee made and, to a lesser extent, marketed in Nama Jindeyka.

Inadequate levels of nutrition under both irrigated and semibarani conditions were reflected in poor production per head and low calving percentages per mature breeding animal. The market value of green fodder in both cases was high, reflecting the considerable pressure being exerted on feed resources in the Punjab by the rapidly increasing sheep and goat populations and the loss of productive land as a result of increasing saline, alkaline, and water-logged areas. In all cases a considerable amount of family labour (6–7 hours/day) was required to support the various milk production activities.

The survey findings were summarized in gross margin form. In each case, three gross margins were compiled. First, a cash gross margin (Table 1) was calculated in which only actual cash sales and cash expenditure were included. Second, home consumption of milk, butter, ghee, and farmyard manure were valued at farmgate prices to provide an estimated total value of production to the family. Cash expenditure was deducted to calculate the farm household gross margin (imputed market value and direct costs column). Finally, the total value of production and imputed market values for fodder and family labour were used to provide an estimate of the economic gross margin (shown in the imputed market valuation and imputed labour column).

The typical farmer in the irrigated village of Bohiwal (Table 1) showed a negative cash gross margin of Rs 700/household. The cash cost of producing milk was Rs 1.76/L and the liquid milk price was Rs 2.20/L. Liquid milk sales made up 48% of total income. The addition of home-consumed products (valued at farmgate prices) and farmyard manure increased income to Rs 5400. Total income may be underestimated by two principal factors. First, there is a good argument, particularly in the case of small-scale farmers, of valuing home-consumed products at the current retail milk or ghee price prevailing in the adjacent market centre. This would add a minimum of 25% to the value of milk and ghee. However, the dilution or pollution of liquid milk, which is common, makes it virtually impossible to assess the true market value of pure 6% milkfat buffalo milk. Again, in the case of draft animals, information was obtained on actual use of draft animals compared to tractor cultivation, electric or diesel tubewells, etc. When fodder costs are valued at market rates and family labour assessed at the average daily cost of one labour unit, the economic gross margin is negative. In this example, the economic gross margin is negative even when the imputed value of labour is zero. Given that the buffalo population is rising by a small (3%/year) amount and that the milch cattle population growth is slightly positive, it appears that the following factors are important stimulants to motivate small-scale farmers dairy production: (a) there are considerable intangible benefits in dairy livestock as an asset, which demonstrates real growth over time; (b) the subsistence value of home-produced milk is very important; (c) there are considerable social and prestige benefits of owning large dairy-type animals; and (d) the high market value of green fodder is a function of the small volume traded

[4]Detailed information about farm structure, land use, and costs and income figures are to be presented in internal working papers available from LPRI, Bahadurnagar.

Table 1. Financial analysis for the irrigated area (near Lahore) for the average farm (2.68 milch animals) and tenant (2.73 milch animals) household.

	Farm household					Tenant household				
	Cash gross margin	%	Imputed market value and direct costs	Imputed market valuation and imputed labour	%	Cash gross margin	%	Imputed market value and direct costs	Imputed market valuation and imputed labour	%
Income										
Milk	1045.29	48.7	2463.31	2463.31	45.6	1202.89	37.8	2382.36	2382.36	36.1
Butter	486.73	22.7	1362.84	1362.84	25.2	685.51	21.6	1958.59	1958.59	29.7
Ghee	97.35	4.5	292.04	292.04	5.4	391.72	12.3	587.58	587.58	8.9
Livestock sales	516.00	24.1	516.00	516.00	9.6	899.00	28.3	899.00	899.00	13.6
Farmyard manure	—	—	769.46	769.46	14.2	—	—	771.00	771.00	11.7
Total	2145.37	100.0	5403.65	5403.65	100.0	3179.12	100.0	6598.53	6598.53	100.0
Expenditure										
Purchases	1022.00	35.6	1022.00	1022.00	13.1	1642.00	45.0	1642.00	1642.00	17.5
Feeding										
Green fodder	1066.00	37.1	1066.00	2132.00	27.4	1238.00	33.9	1238.00	2476.00	26.3
Dry fodder	332.98	11.6	332.98	608.16	7.8	180.46	5.0	180.46	541.74	5.8
Concentrate	284.00	9.9	284.00	284.00	3.6	383.00	10.5	383.00	383.00	4.1
Labour										
Family	—	—	—	3580.65	45.9	—	—	—	4161.00	44.2
Hired	—	—	—	—	—	—	—	—	—	—
Grazing	—	—	—	—	—	—	—	—	—	—
Breeding	—	—	—	—	—	—	—	—	—	—
Animal health	27.60	1.0	27.60	27.60	0.4	29.80	0.8	29.80	29.80	0.3
Miscellaneous	139.85	4.8	139.85	139.85	1.8	173.64	4.8	173.64	173.64	1.8
Total costs	2872.43	100.0	2872.43	7794.26	100.0	3646.90	100.0	3646.90	9407.18	100.0
Cost/litre	1.76		1.76	4.78		1.66		1.66	4.29	
Gross margin	(727.06)[a]		2531.22	(2390.61)		(467.78)		2951.63	(2808.65)	

[a]Figures within parentheses indicate a negative value.
Note: All monetary values are in Rupees (as of 1982, Rs 10.50 = U.S.$1.00).

Table 2. Financial analysis for the semibarani area (near Haveli) for the average farm (1.8 milch animals) and tenant (2.0 milch animals) household.

	Farm household					Tenant household				
	Cash gross margin	%	Imputed market value and direct costs	Imputed market valuation and imputed labour	%	Cash gross margin	%	Imputed market value and direct costs	Imputed market valuation and imputed labour	%
Income										
Milk	406.43	22.0	1200.16	1200.16	20.3	387.30	47.6	832.20	832.20	27.4
Butter	—	—	—	—	—	—	—	—	—	—
Ghee	1328.60	72.0	3985.80	3985.80	67.3	386.90	47.5	1257.43	1257.43	41.4
Livestock sales	110.00	6.0	110.00	110.00	1.9	40.00	4.9	40.00	40.00	1.3
Farmyard manure	—	—	624.00	624.00	10.5	—	—	905.00	905.00	29.8
Total	1845.00	100.0	5919.96	5919.96	100.0	814.20	100	3034.43	3034.43	99.9
Expenditure										
Purchases	380.00	18.6	380.00	380.00	6.5	212.00	9.7	212.00	212.00	2.9
Feeding										
Green fodder	788.50	38.5	788.50	2389.40	40.7	1308.49	59.8	1308.49	3965.13	55.0
Dry fodder	20.35	1.0	20.35	250.36	4.3	101.01	4.6	101.01	277.55	3.8
Concentrate	250.00	12.2	250.00	250.00	4.3	114.00	5.2	114.00	114.00	1.6
Labour										
Family	—	—	—	1989.25	33.9	—	—	—	2190.00	30.4
Hired	255.50	12.5	255.50	255.50	4.4	—	—	—	—	—
Grazing	251.26	12.3	251.26	251.26	4.3	275.17	12.6	275.17	275.17	3.8
Breeding	—	—	—	—	—	—	—	—	—	—
Animal health	15.00	0.7	15.00	15.00	0.3	32.50	1.5	32.50	32.50	0.5
Miscellaneous	85.80	4.2	85.80	85.80	1.4	146.00	6.7	146.00	146.00	2.0
Total costs	2046.41	100.0	2046.41	5866.57	100.1	2189.17	100.1	2189.17	7212.35	100.0
Cost/litre	0.57		0.57	1.64		0.61		0.61	2.01	
Gross margin	(201.41)[a]		3873.55	53.39		(1374.97)		845.26	(4177.92)	

[a]Figures within parentheses indicate a negative value.
Note: All monetary values are in Rupees (as of 1982, Rs 10.50 = U.S. $1.00).

(relative to total consumption) and would not be sustained if a higher proportion were to be traded, i.e., the market value in the calculation may be overestimated.

In the case of tenants living in the irrigated village of Bohiwal (Table 1) a similar set of gross margins was derived. The cost of production was slightly lower (Rs 1.66/L) than for farmers, but it appears that their intensive approach to land operation (as reflected by a cropping intensity of 180% for the tenants compared with 105% for the farmers) was channelled into the more directly rewarding cash crop enterprises. The different nature of the semibarani area of Nama Jindeyka was clearly demonstrated by the cost structure (Table 2). The cash cost of liquid milk was Rs 0.57/L and the economic cost was Rs 1.64/L. On the income side liquid milk made up only 22% of cash income as compared with ghee sales of 72% of the total. Compared with the farmers in Bohiwal the overall level of return was considerably better with only a small cash deficit estimated and the economic gross margin was just positive. This indicates a return to family labour close to the current market cost of labour.

The situation regarding tenants (Table 2) was, however, not so encouraging. They had a much lower cash income (44%) compared with the farmers. This was due to two factors. First, the tenants' animals were considerably less productive than were the farmers' animals. Second, and this has an important impact on the first reason given, the tenants required almost twice as much fodder area to support their livestock. This was due to the poor quality of the land leased by tenants and the limited availability of tubewell irrigation water for these lands. The need to cultivate larger areas of land to support only a slightly greater number of livestock per household has of course an important impact on the costs of production of green fodder.

The results of the survey, when summarized in terms of gross margins, provide an interesting insight into the motivation of farmers to maintain dairy production. Despite negative cash and economic gross margins, smallholders and landless people have maintained a significant proportion of their assets in dairy animals. It is suggested that the gross margin based on imputed market values less cash costs most closely approximates the livestock holders motivation for maintaining dairy production activities by accounting for intangible and difficult to quantify benefits. The study also indicates the strong subsistence nature of dairy production in the Punjab. The structure and cost basis of the two dairy livestock production systems represented, suggest that only a small increase in output of liquid milk could be expected from significant increases in liquid milk prices. The differences in cost structure between the two areas also indicate the need for a flexible farmgate milk price strategy. To obtain increased dairy production, it will be necessary for the government to support a positive pricing policy, balanced between consumer and producer demands, by initiating a dynamic dairy-development program based on improved fodder production, adequate animal health services, and producer-oriented marketing facilities.

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Investment in Livestock in Nepal

Ramesh P. Sharma[1]

Abstract. This paper identifies the factors that influence the decision of Nepalese farm households to invest in livestock. The study uses household data based on nine locations in Nepal. The typical Nepalese farm is an intricate system composed of crops, livestock, household, natural resources, and market sectors. Thus, choice in one specific area is a function of the entire system.

Total livestock units (LSU), average 5.2 per household with a coefficient of variation across locations as small as 23%. Most households raise almost all types of animals. This similarity is due to the subsistence nature of the economy in which the contribution of each type of animal becomes necessary. Buffalo, cattle, oxen, and goats predominate. However, there are differences across locations in the types of animals.

Although both cows and buffalo are milch animals, farmers invest more heavily in buffalo in areas accessible to markets, whereas the reverse is true in inaccessible areas. This pattern arises from the larger milk output from buffalo. An exception to this pattern occurs where there is a severe shortage of fodder (forest). Where markets are accessible, it is advantageous to own buffalo rather than goats. Nevertheless, almost all households have cows and goats, in part due to religious reasons and, in the case of cows, the need for oxen for draft purposes. Swine and poultry are generally confined to lower-caste groups. Use of chemical fertilizers is negligible so animal manure is an important product of livestock. Livestock is the least researched part of Nepalese agriculture. Four areas are identified for further research.

Résumé. L'étude traite des facteurs susceptibles d'influencer la décision du cultivateur familial du Népal d'acquérir des bestiaux. Elle s'appuie sur des données recueillies auprès de foyers agricoles dans neuf endroits du Népal. La ferme népalaise typique est un ensemble complexe où interviennent les plantes cultivées, les bestiaux, la composition de la famille, les ressources naturelles et les marchés disponibles. Ainsi, tout choix intéressant un secteur particulier est fonction du système entier.

Le nombre total d'unités de bestiaux (LSU) par foyer est en moyenne de 5,2 avec un coefficient différentiel entre les endroits se réduisant parfois à 23 p.100. Dans la plupart des foyers, on élève à peu près tous les genres d'animaux, similitude attribuable à l'économie de subsistance de cette région, dans laquelle chaque genre d'animal apporte sa contribution particulière. On y rencontre surtout le buffle, des bovins, des bœufs de trait et des chèvres avec, cependant, des différences dans les genres d'animaux prédominants, selon les endroits.

Bien que la vache, comme le buffle, donne du lait, les cultivateurs habitant des endroits où existent des marchés préfèrent se pourvoir de buffles plutôt que de vaches tandis que c'est le contraire dans les régions inaccessibles ; la femelle du buffle donne en effet plus de lait que la vache. Cette tendance connaît des exceptions dans les régions (forestières) particulièrement dépourvues de ressources fourragères. Là où l'on a accès à des marchés, le buffle se révèle plus avantageux que les chèvres. Néanmoins, presque tous les foyers possèdent à la fois des vaches et des chèvres, en partie pour des motifs religieux et, dans le cas des vaches, pour s'en servir comme bêtes de trait. Les porcs et la volaille sont généralement réservés aux groupes de castes inférieures. L'usage d'engrais chimiques étant presque inexistant, le fumier constitue un produit animal important. Le secteur des bestiaux est celui qui est le moins approfondi de l'agriculture népalaise. Quatre secteurs précis méritent d'être étudiés attentivement.

The Nepalese farm is subsistence in nature (Wharton 1969). The farm system, shown in Fig. 1, indicates the choice framework faced by a farmer. The flow of specific resources includes from livestock to: crops (manure, farm power, and transport), household (milk, ghee, meat, eggs, cash income, emergency financial security, employment, and for religious necessities), and market (milk/ghee, meat/eggs, wool, and hides); to livestock from: forest/garden (fodder and grass), pasture (grazing (feed), crops (crop residues as feed), and household (labour and capital inputs).

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A closer examination of Fig. 1 reveals that farmers are guided by more than one criterion in the management of their farms. It may be a combination of factors such as maximization of profit, security in terms of food and nutrition, and minimization of risk and uncertainty. In such a system a particular decision is evaluated on the basis of its impact on the entire structure (Pachico 1980).

Therefore, the main objectives of this paper are: to describe the interrelationships between livestock and other components, which form the Nepalese farm system, and to indicate the flow of specific resources from and to the livestock component. Factors will also be identified that structure the farm household choice with regard to total livestock units and compositional structure of the total livestock population. Areas for research on livestock economics will also be suggested.

The government does not regularly collect livestock data, but data are collected every 10 years as part of the agricultural census. Similarly, some information is collected in periodic agricultural surveys. This paper, based on secondary sources of information, includes six studies covering nine locations. Intertemporal variation in these data sources is small (1977–82). The nine study areas and their references are given in Table 1.

Results of Analysis

Livestock Population per Household

Livestock units (LSU) per household for different parts of Nepal are shown in Table 1. The average for the nine areas is 5.2 LSU/household. The very small coefficient of variation (23%) indicates only a minor variation across the nine areas. In all areas, the average sample household maintains all types of animals, the main reason being the primarily subsistence nature of the agricultural economy, in which a contribution from each type of animal becomes necessary. Table 2 shows that about 92% of total LSU comes from four animals: buffalo, cow, goat, and oxen.

Although the coefficient of variation in total LSU per household across regions is very small, it is not so for different types of animals (Table 1). Except for oxen, the coefficient of variation for the other animals is relatively large, and, therefore, the compositional structure of the total livestock population across regions is different as shown in Table 2.

In the accessible areas, buffalo alone contribute 56% to total LSU, and 15% in the inaccessible areas. In view of the similarity in total LSU per household across Nepal, it is obvious that households invest in the type of animal more appropriate for their specific environment. This diverse pattern of investment in LSU across districts merits analysis on an animal-by-animal basis.

Composition of Livestock Population

Buffalo

Milk yields from cows are very low in Nepal compared with buffalo; therefore, milk is the main factor for investing in buffalo. In contrast to cows, the raising of buffalo appears to be strongly correlated with

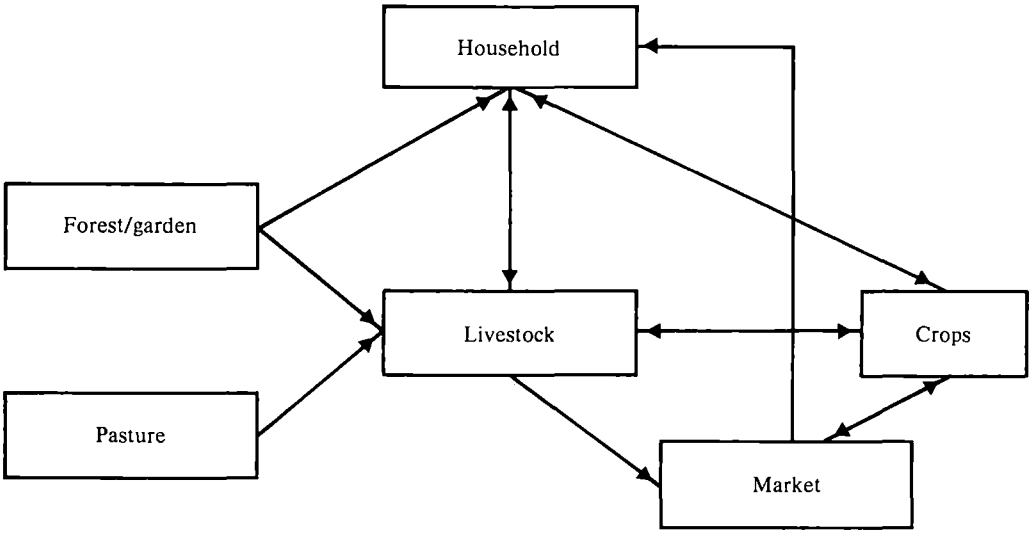

Fig. 1. The farm system indicating the choice framework faced by a farmer.

Table 1. Average number of different animals per household.

Study area	Buffalo	Cows	Oxen	Calves	Goats	Sheep	Pigs	Poultry	Total livestock units[a]
Chitwan	2.75	0.88	1.80	0.62	0.39	—	—	—	6.51
Pumdi Bhumdi	1.76	0.13	0.61	0.79	1.46	—	0.02	2.35	3.82
Khandbari	0.45	1.00	1.45	1.14	2.27	—	0.36	4.90	4.48
Kosi Hills	0.58	1.40	1.70	—[b]	2.00	—	0.22	—	4.38
Udayapur	0.74	2.13	2.03	2.31	4.03	0.03	0.01	2.60	7.39
Siraha/Saptari	0.63	1.26	1.92	1.13	1.33	—	—	0.48	4.89
Dadeldhura	0.70	1.71	1.58	—	1.20	—	—	0.10	4.47
Chilaunebas	2.20	0.53	0.83	—	0.70	1.00	—	1.17	4.59
Waling	2.67	1.40	1.43	—	0.10	0.20	—	—	6.24
Average	1.39	1.16	1.48	1.20	1.50	0.41	0.15	1.93	5.20
Coefficient of variation	69	52	32	55	79	127	113	91	23

[a]Livestock units aggregated with the following weights: buffalo = 1.25; cows, oxen = 1; calves = 0.5; goats, sheep, pigs = 0.25; poultry = 0.05.

[b]Dashes indicate that there were either none of these animals in the area or they were not covered in the study.

Source: Chitwan, Shivakoti et al. (1977); Pumbi Bhumdi and Khandbari, Mathema and Van Der Veen (1980); Kosi Hills, Dutt (1979); Udayapur and Siraha/Saptari, APROSC (1982); Dadeldhura, APROSC (1979); and Chilaunebas and Waling, ADC (1982).

Table 2. Average number of different animals and their contribution of total livestock units in accessible and inaccessible areas.

	Buffalo		Cows		Goats		Oxen	
Study area	Number per household	% contribution[a]	Number per household	% contribution	Number per household	% contribution	Number per household	% contribution
Accessible								
Chitwan	2.75	53	0.88	13.5	0.39	1.5	1.80	28
Pumdi Bhumdi	1.76	58	0.13	3.4	1.46	9.5	0.61	16
Chilaunebas	2.20	60	0.53	11.5	0.70	3.8	0.83	18
Waling	2.67	64	1.40	22.4	0.10	0.4	1.43	23
Average	2.34	56	0.73	12.7	0.66	3.8	1.17	21
Inaccessible								
Khandbari	0.45	12	1.00	22.3	2.27	13.0	1.45	32
Kosi Hills	0.58	17	1.40	32.0	2.00	11.0	1.70	39
Udayapur	0.74	12	2.13	29.0	4.03	14.0	2.03	27
Siraha/Saptari[b]	0.63	16	1.26	39.0	1.33	7.0	1.92	39
Dadeldhura	0.70	20	1.71	38.0	1.20	7.0	1.58	35
Average	0.62	15	1.52	32.0	2.17	10.4	1.74	34

[a]Percentage contribution = (number of animals × weight) × (100/total livestock units).

[b]Siraha/Saptari are Tarai districts accessible by road. This is an exceptional case and illustrates the fact that severe feed/fodder constraints outweigh the advantages of raising a larger number of buffalo.

Source: Table 1.

marketing prospects. Apart from constraints on marketing and milk products, other hindrances in owning buffalo are the availability of feed and fodder, a very steep terrain, and the alpine climate.

The average number of buffalo per household in the study areas is 1.39 (Table 1). Although the ownership pattern per household in different locations is not uniform. A regrouping of the nine samples into those with easy access to markets and those in inaccessible areas (Table 2) gives a clue to investment in buffalo.

Table 2 shows that the average number of buffalo in the accessible areas is almost four times the average found in the inaccessible areas, and almost four times the contribution of buffalo to total LSU compared with the inaccessible areas. These figures indicate the preference for investment in buffalo by all farmers given the marketing opportunity. The

exceptional case of Siraha/Saptari reflects the importance of the feed and fodder constraint in this area.

The importance of marketing is also revealed by two contrasting sets of data reported in Mathema and Van Der Veen (1980). In Pumdi Bhumdi, an accessible area, there was little relation between the number of buffalo owned and farm size. Even the smallest farm households owned at least one buffalo. On the other hand, in Khandbari, an inaccessible area, 80% of the buffalo were on farms larger than 1 ha. Therefore, if there is a marketing prospect, small and marginal farmers will also benefit from buffalo, which provide substantial financial support for these farmers whose income from crops is very small.

Cows

Compared with buffalo, cows are generally kept for home consumption of milk because of the very low milk yield and, hence, little marketable surplus. Also, cow milk is inferior, due to different fat content, to buffalo milk in the preparation of "ghee," which is a lucrative milk product in terms of cash income. Nevertheless, cows are owned by almost all farmers as oxen and for religious considerations. Although most farmers own cows, the average number of cows per household is only 1.16 (Table 1), and the coefficient of variation is relatively smaller.

The average number of cows per household in the inaccessible regions is more than two times that in the accessible regions, the percentage contribution to total LSU is slightly more than 2.5 times. There is, therefore, an inverse investment pattern for cows and buffalo. Cows are invariably grazed and are easier to maintain than buffalo, so these factors are relatively unimportant in explaining the variation in investment pattern for cows in different regions. An important decision factor behind investment in cows may be the number of infants and children in a household; they would create a demand for cow milk, however, data are not available to substantiate this factor.

Based on these observations, the opening of marketing opportunities will lead to a substitution of buffalo for cows if the net returns, in terms of milk yield and associated costs, are in favour of buffalo. The degree of substitution would be limited as most farmers need a cow for its off-spring (oxen) and for the religious value it holds.

Oxen

In the sample studies, about 60% of the households owned at least one or possibly two oxen and in a few cases more than two for plowing purposes. The distribution of oxen ownership is rather skewed as in Pumdi Bhumdi, where 88% of the oxen are owned by 59% of farms with more than 0.6 ha; and in Waling, where 72% of the oxen are owned by 50% of farms with more than 0.58 ha. As well, in Khandbari, 87% of the oxen are owned by farms with more than 0.6 ha. Thus, it appears that many of the very small-scale farmers, with less than 0.6 ha, do not own oxen at all.

In general, a positive correlation can be observed between the number of oxen and the size of holding. The relationship, however, is not uniform so there is no fixed installed draft power per hectare. This is evident from the Pumdi Bhumdi study (Table 3). These figures show that even on a per hectare basis, larger farms have a larger number of installed draft power. Variable ratios of installed draft power per hectare indicate the importance of other factors besides the amount of available land in influencing the decision made by farmers to invest in oxen.

One important factor may be availability of human labour, a close substitute for oxen. Given the availability of considerably large amounts of surplus labour (Sharma 1982), and the poor off-farm employment prospects for small farmers, family labour may indeed be acting as a substitute for oxen labour. Generally, human labour use is negatively related to farm size (Ministry of Food and Agriculture 1971).

On a country-wide level, districts with larger than average land holding per capita also have more oxen. For instance, the average number of oxen per household in the Tarai and inner Tarai districts (Siraha/Saptari, Udayapur, and Chitwan) is 1.92 compared with 1.5 in the hilly districts.

Table 3. Number of oxen and size of holding in Pumdi Bhumdi.

Holding groups (ha)	Average size (ha)	Average no. of oxen	Oxen/ha
<0.4	0.2	0.08	0.40
0.4–0.6	0.5	0.29	0.58
0.6–1.0	0.8	0.73	0.91
>1.0	1.2	1.11	0.92

Source: Mathema and Van Der Veen (1980).

Goats

Goats are commonly raised by Nepalese farmers for meat, cash income, and also for security during crop failures and lean seasons as well as being essential for certain religious sacrifices. It is also easier to raise goats compared with larger animals, because goats can survive on homestead garden grazing and household leftovers. The average number of goats per household in the nine study areas is shown in Table 1, and the spatial variation, as indicated by the coefficients of variation, is the highest. Table 2 shows the average number of goats per household in the two types of areas, and compared with the accessible areas, the average number of goats per household and the contribution to total LSU is about three times higher in inaccessible areas.

These two groups do not differ greatly in terms of topography, climate, ethnic characteristics, and feed situation. The smaller number of goats in areas with greater access to markets appears puzzling. One possible explanation may be the advantages of investing in other types of animals. In view of the relatively larger number of buffalo per household in the accessible areas and the large cash income from buffalo milk, it is quite possible that farmers may have chosen to invest more in buffalo than in goats.

Sheep

There is not much information on sheep in the selected studies. Sheep are normally raised in the northern (alpine) part of Nepal for wool and meat. The mountainous region of Nepal appears to be a suitable sheep-farming zone for high-quality wool. Research on the economics of livestock in general and that of sheep farming in particular will be conducted in the near future.

Pigs and Poultry

Pig farming is not as uncommon as is indicated in Table 1, but it is limited to ethnic groups considered as low castes in the Hindu religious hierarchy. Poultry farming, to a certain extent, also belongs to this group, but it is less restricted than pig farming in terms of being limited to one particular caste group. The low average figures of these livestock units per household and the very high coefficients of variation are due to the fact that only a subsample belonging to certain caste groups of households raise these units. Chickens are preferred to pigs because they are small, easy to raise, and are easily marketed as are eggs and meat.

Manure from Livestock

Manure is a very important livestock product and is highly prized by farmers. All livestock provide manure for crops, but it is not known to what extent it accounts for the variation in the compositional structure of the livestock population. Chemical fertilizers do not appear to be a substitute for organic manure in the near future. This fact will continue to exert a strong influence in raising livestock by all farmers as part of the overall farm system.

Priority Areas for Research

The livestock sector is the least researched field of agriculture in Nepal, in both socioeconomic and technical terms (Sharma 1981). There are several areas where research is required:

- The limits in this paper studying the portfolio choice of livestock producers in determining producer investment in livestock have been set by the available data and methodology. Further detailed study is essential;
- Serious concerns have often been raised about the effect of a large livestock population on land in Nepal. In view of severe deforestation and ecological damage, partly caused by the livestock population, the issue of the carrying capacity of land in terms of optimum livestock population remains an important one. This issue calls for livestock sector planning in terms of carrying capacity of the entire system. The methodology developed by Mishra (1978) for India might be applied to the Nepalese livestock sector;
- There exists considerable scope for increasing livestock productivity in Nepal, but this will depend primarily on livestock research. Neither expost nor exante research resource allocation studies have been made in Nepal so far, and these remain priority research areas; and
- Some attempts have been made in the past to introduce improved livestock technology, such as an improved breed of animals, but with little success. The reasons behind this rejection of improved technology in the present farm system are not clear. Further research in this area is required to ensure successful modernization of the livestock production system.

Microeconomics of Rural Livestock: the Case of Buffalo and Cattle in Thailand

Theodore Panayotou[1] and Ruangrai Tokrisna[2]

Abstract. This paper discusses the role of livestock in the rural economy, the optimum holding age for a single animal is determined, and the size of the herd and its age and sex composition are analyzed. Complications such as dual-purpose animals, indivisibilities, and trade in draft animals are also mentioned. Concluding remarks and implications for policy are given.

Résumé. Il est question ici du rôle du bétail dans l'économie rurale, de l'âge optimal pour se défaire d'un animal, de l'analyse d'un troupeau quant à sa taille et sa composition en âges et en sexes. On passe en revue des situations plus complexes, comme celle des animaux à double production, celle des indivisibilités, celle des échanges et remplacements des animaux de trait. On trouvera encore ici des remarques conclusives et l'impact de certains choix politiques.

The traditional livestock sector in Thailand has received a new impetus in recent years from a rising demand for meat and a growing supply of animal feed. However, unlike the poultry and swine industries, which have experienced remarkable growth, the buffalo and cattle subsector continues to be relatively stagnant, especially in terms of the standing stocks from which increasing numbers of animals are drawn for slaughter.

The supply of buffalo and cattle for slaughter during the 1970s grew at the rate of 3.0 and 5.3%/year compared with 1.2 and 1.1%, respectively, during the 1960s. In contrast, the standing stock of buffalo grew only by 0.6% and that of cattle declined by 0.9%/year during the 1970s compared with a growth of 1.7 and 2.9%/year, respectively, during the 1960s (for an overview of the livestock sector in Thailand with an emphasis on buffalo and cattle see Tokrisna and Panayotou, this volume).

Under these circumstances, concerns are voiced that unless stocks are built up, the recent increases in beef supply will not be sustainable. Moreover, it is feared that the dwindling stocks will result in shortages of animal draft power for the farming sector and undue farm mechanization. In response, policies to encourage the buildup of the buffalo and cattle stocks are being considered in addition to existing restrictions on the slaughter of breeders and healthy draft animals. However, the formulation of effective policies requires an understanding of the factors behind the changes in the stocks of animals held.

To explain variations in any form of aggregate activity it is first necessary to understand the behaviour of the microunits of which it is comprised. In the case of livestock, we need to understand the objectives and constraints of livestock producers and traders (for an explanation of variations in aggregate see Tokrisna and Panayotou, this volume). Who are the livestock producers and why do they raise/keep the animals? What determines the age at which the animals are sold for slaughter? What determines the number, age, and sex structure of animals held in stock and, by implication, of those that are added or withdrawn from the stock?

In this paper the role of livestock in the rural economy is discussed, the optimum holding age for a single animal is determined, and the size of the herd and its age and sex composition are analyzed. Complications such as dual-purpose animals, indivisibilities, and trade in draft animals are also mentioned. Finally, concluding remarks and implications for policy are given. Because of the exploratory nature of the study, the results should be regarded with

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some caution pending the completion of a follow-up econometric analysis of gross additions to the stocks based on the microfindings developed here.

Livestock in the Rural Economy

With the exception of a small number of commercial ranches, most buffalo and cattle in Thailand are kept by small-scale farmers, particularly in the northeastern region of the country. Farmers raise buffalo and cattle as part of their overall farming activities with the primary purpose of using them as draft animals for plowing their croplands. Other related services of the animals include their use as a means of transport and as a source of fertilizer for paddy and other cropland. Livestock's contribution to crop yields may be measured by the value of its marginal product, i.e., the value of the increase in rice production as a result of 1 more hour of plowing or one more unit of fertilizer. Alternatively, the value to the farmers of one unit of animal power may be represented by the rental price of an equivalent unit of animal or mechanical power, which the farmers would have to pay if they were not keeping their own animals.

At the end of their "economic life" as draft animals, buffalo and cattle are sold for slaughter, thereby also serving as a source of cash income. How this economic life is determined will be discussed in the sequel. The replacement of old animals sold for slaughter takes place either through purchase or through breeding. For breeding it is necessary to keep some female buffalo or cattle. Occasionally the farmers may sell calves in excess of replacement or they may raise them to maturity or to some "optimum" age and then sell them as draft animals, as breeders, or for slaughter depending on their sex and prices. Thus, farmers may keep cattle and buffalo of four different types: mature male animals for draft power, mature female animals for breeding (or for dual purpose), calves of both sexes for replacement, and surplus calves of both sexes for sale. This suggests that a farmer would have a herd of a certain size, age, and sex structure based on factors that will be discussed in detail below.

Up to this point we have discussed a number of benefits from keeping livestock. Let us now consider the costs. Costs must include land and/or some form of feed, labour for feeding and tending, and some capital in the form of shelters, pens, watering troughs, and, of course, in the form of the animal itself. Which of these costs are relevant to the Thai farmer/livestock raiser? Very rarely would a Thai farmer devote arable land to livestock unless it is fallow or just after the harvest and before the next planting. In fact, agricultural residues and farm wastes, such as rice stubble, rice straw, weeds, etc., often constitute the main source of feed for buffalo and cattle as well as for other livestock that the farmer keeps. Another source of feed is communal or village pastures such as hilly land, reserved forests, and grass along waterways, roadsides, etc. A third source of feed is reserved forests and other common property or open-access land that, unlike communal pastures, are not recognized as pertaining to any particular village. Very rarely is any concentrated feed used.

Labour is needed mainly for herding the animals. Labour needs are highest when all cropland is planted and the animals need to be guarded carefully. At other times, labour is needed to prevent straying, theft, fighting, and to aid in birth. The main source of labour for herding is underemployed members of the household, particularly children, and occasionally the farmers' wives, relatives, or older people. The only labour the farmers themselves may provide is for cutting grass and weeds and stacking rice straw as supplemental roughage (De Boer 1972, p. 106).

Usually, only very little capital is committed to livestock in Thailand, mainly in the form of storage of rice straw and some primitive shelters, fencing or any form of ranching is still quite rare. In fact, the main capital is the investment in the stock of the animals. Each animal is a capital asset in every sense of the term; it embodies past investments, it produces services, it requires maintenance, and it can be liquidated and reinvested. By keeping the funds locked in a given animal it imposes costs in the form of maintenance and foregone interest or return on alternative investments, whereas it yields a return in the form of increased weight, draft power, or breeding.

Therefore, the costs of keeping buffalo or cattle by small-scale farmers in Thailand are minimal: agricultural residues and farm wastes have often zero or very low opportunity costs, communal pastures and open-access forests have definitely zero opportunity cost from the individual farmer's point of view, and the opportunity cost of the labour of children and other underemployed members of the family is quite low especially between planting and harvesting when the labour requirements for herding are highest. Thus, from the individual farmer's perspective, livestock is a very cost-effective means of converting agricultural wastes and underemployed labour into capital; it is, moreover, a means of converting common property resources (communal grazing land, forest pastures) into private property (livestock). In the rural economy of Thailand, as well as of those of other developing countries, the raising of livestock is often the only form of capital

formation taking place. This aspect has often led researchers to describe, rather incorrectly, livestock in developing countries as a store of value and a hedge against inflation.

Optimum Holding Age

Consider a farmer who keeps a single buffalo and is contemplating whether to sell it now or keep it for 1 more year. What factors does the farmer need to take into account and what would the decision rule be? On the one hand, keeping an animal for 1 extra year provides benefits in terms of (a) an increase in value due to increase in weight or price or both and (b) the provision of services, draft power by males and calves by females. On the other hand, keeping an animal for 1 more year involves certain costs in terms of (a) maintenance (labour and feed), (b) foregone interest on the current value of the animal, and (c) some probability that the animal will be lost to theft or disease.

Depending on the relative magnitude of the costs and benefits involved, the farmer would decide whether to sell the animal now or keep it for 1 additional year. The farmer's decision rule is simple: keep it if the benefits of an extra year's keep exceed the corresponding cost; sell it if the benefits fall short of the costs. The equality of benefits and costs of waiting, which may be called the marginal benefits and marginal costs of time, respectively, determine the "optimum" age at which the animals are sold (usually for slaughter). Formulated algebraically the optimality condition is:

$$(1) \quad V'(t) + s(t) = r \cdot V(t) + a(t) + b \cdot V(t)$$

where $V(t) = p(t) \cdot Q(t)$ is the market value of the animal at time t, which equals the product of price p and quantity Q, each at time t; $V'(t) = dV(t)/dt$ is the change in the value of the animal due either to a change in its weight, $dQ(t)/dt$, or to a change in its price $dP(t)/dt$; $s(t)$ = the value of the services provided by the animal during the year, in the case of a draft animal $s(t)$ is the value of the plowing and other draft work done during the year, in the case of a breeding animal $s(t)$ is the value of calves produced during the year, for dual-purpose animals it is the sum of both, the value of manure produced during the year is also included in $s(t)$, as is the value of any transport services provided; r = the rate of interest of return from alternative investments available to the farmer; $a(t)$ = the cost of maintenance (labour, feed, etc.) of the animal for 1 year; and b = the probability of loosing the animal to theft or disease. The left-hand side of equation (1) is the marginal benefit of time and the right-hand side the marginal cost of time. Then the decision rule in terms of equation (1) becomes: if $V'(t) + s(t) > (r + b)V(t) + a(t)$, keep the animal; if $V'(t) + s(t) < (r + b)V(t) + a(t)$, sell it; and if $V'(t) + s(t) = (r + b)V(t) + a(t)$, indifferent (optimum age for sale). An example of the determination of optimum age of sale/slaughter is presented in Tables 1 and 2 using cross-section data from De Boer (1972) for a Thai village in 1970. (The use of cross-section data for the determination of optimum age is not entirely satisfactory; ideally, the use of time-series data is preferred.) Table 1 presents estimates of the main variables of the model under two alternative rates of interest (12 and 18%) and probabilities of loss through theft and disease (5 and 7.5%). The annual cost of maintenance (labour, capital, and feed) is assumed to be the same, 500 baht (as of 1970, 20 baht = U.S.$1.00), regardless of the age of the animal. The value of services provided by the animal is assumed to be zero for ages under 4 and above 11, 1000 baht for ages 4–5 and 10–11, and 1400 baht for ages 5–10. What is changing between ages is the value of the animal, presumably due to biological growth. As one would expect, the value of an animal grows rapidly during the early stages of its life, between zero and 4 years, it tapers off toward maturity, remaining at about the same level during the rest of the animal's productive life (Fig. 1) and declines thereafter. Two components of the cost of keeping the animal for an extra year, foregone interest and risk, change over the life of the animal as a result of the change in its value (Table 1).

Table 2 compares the benefits and costs of keeping animals of different ages for an additional year. At a 12% interest rate and 5% probability of loss through theft or disease the optimum age of selling the animal for slaughter is at its 11th year. At an 18% interest rate and 7.5% probability of loss, the optimum age is 1 year earlier, at the 10th year; keeping the animal for an additional year brings about a net loss of 772 baht. Thus, an increase in the interest rate or the probability of loss due to an epidemic or more robberies would induce farmers to get rid of their older livestock.

The effects of other changes in exogenous variables or policy parameters can be studied through equation (1). For example, the introduction of improved breeds would be reflected in a faster growth and, hence, a larger $V'(t)$, in more services, $s(t)$, either in the form of stronger draft animals or higher breeding rates, or both, and in a lower incidence of disease and, hence, lower b. Vaccination and improved nutrition may have a similar effect. Other things being equal, such changes would tend to induce a lengthening of the optimum age, provided that the costs of such measures are relatively small or that they are borne by the government. It is also possible for improved breeds and nutrition to shorten

Table 1. Basic calculations for the determination of optimum holding age of cattle using 1970 figures from a Thai village.

Age	V(t)	V'(t)	$r_1V(t)$	$b_1V(t)$	$r_2V(t)$	$b_2V(t)$	s(t)	a(t)
1	325	372	39	17	59	24	0	500
2	697	322	84	35	125	52	0	500
3	1019	776	122	50	183	76	0	500
4	1795	240	215	90	323	135	1000	500
5	2035	21	244	102	366	153	1400	500
6	2056	−89	247	103	370	154	1400	500
7	1967	−19	236	99	354	148	1400	500
8	1948	−4	234	98	351	146	1400	500
9	1944	−172	233	97	350	146	1400	500
10	1772	−173	213	89	319	133	1000	500
11	1599	0	192	80	209	120	0	500

Note: All monetary values are in Baht (as of 1970, 20 baht = U.S.$1.00).

V(t) = current (1970) value in live animal (cattle) of age t.

V'(t) = time rate of change in value of live animals (here represented by the difference in the value of animals of two successive ages).

$r_1V(t)$ = interest foregone at interest rate r_1 (= 12%).

$r_2V(t)$ = interest foregone at interest rate r_2 (= 18%).

$b_1V(t)$, b_2V_t = certainty-equivalent loss of value due to disease or theft at probability b_1 (= 5%) and b_2 (= 7.5%), respectively.

s(t) = value of 1 year's services (draft work).

a(t) = cost of 1 year's maintenance of the animal.

Source: Calculated from figures on cattle values given in De Boer (1972, p. 124, 125, and 208) for male cattle in Nong Jek Lee Village in Lopburi Province of Thailand, 1970. Some interpolations and adjustments of the original figures were made for completeness and clarity of exposition.

Table 2. Determination of optimum holding age of cattle under alternative rates of interest and probabilities of loss.

	$r_1 = 12\%$; $b_1 = 5\%$			$r_2 = 18\%$; $b_2 = 7.5\%$		
Age	MB_t	MC_t	$MB_t - MC_t$	MB_t	MC_t	$MB_t - MC_t$
1	372	556	−184	372	583	−211
2	322	619	−297	322	677	−355
3	776	672	104	776	759	17
4	1240	805	435	1240	958	282
5	1421	846	575	1421	1019	402
6	1311	850	461	1311	1024	287
7	1381	835	546	1381	1002	379
8	1396	832	564	1396	997	399
9	1228	830	398	1228	996	232
10[a]	827	802	25	827	952	−125
11[a]	0	772	−772	0	829	(−829)

[a]Optimum holding age, i.e., at this age the animal would be sold, presumably for slaughter (at age 11 for r_1 = 12% and at age 10 for r_2 = 18%).

Note: All monetary values are in Baht (as of 1970, 20 baht = U.S.$1.00).

Source: Calculated from figures given in Table 3, using equation (1) and the following definitions: $MB_t = V'(t) + s(t)$ = marginal benefit of holding the animal for an extra year, and $MC_t = rV(t) + bV(t) + a(t)$ = marginal cost of holding the animal for an extra year.

rather than lengthen the optimum holding age by inducing faster growth and higher values in the early stages of the animal. Knowledge of the precise growth curve is necessary. A reduction of available pastures would increase the cost of maintenance causing a reduction in the optimum holding age; a similar effect would result from an increase in the wage rate and the cost of supplemental feed.

An increase in the price of live animals may cause a change either way because price appears in both sides of the equation (recall V = p·Q). At zero or very low interest rates and low risk factors an increase in the price of live animals would increase the left-hand side of equation (1) more than the right-hand side, thus, inducing a lengthening of optimum age. The reverse would happen at a very high interest rate and/or a high probability of loss. To predict the effect of higher prices at intermediate values for r and b a numerical solution is necessary.

Finally, we should consider changes outside the livestock sector that might affect the optimum holding age of livestock. We have already seen the effect of changes in interest and wage rates. A reduction in the cost of mechanical power, as was the case in

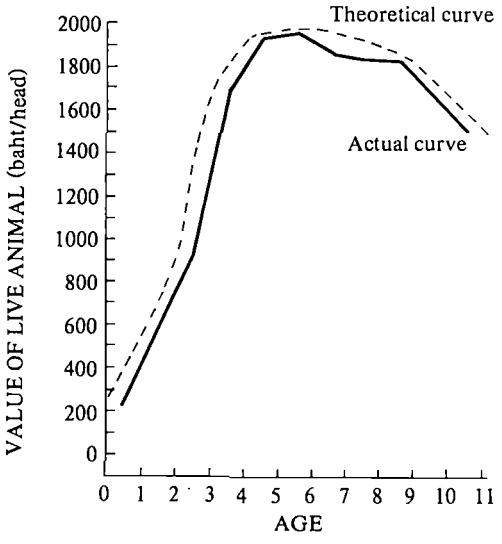

Fig. 1. Average values for male cattle at various age intervals based on figures by De Boer (1972, p. 208) for Nonk Jek Lee village, April 1970–March 1971.

Thailand before the energy crisis,[3] would reduce the value of draft services (s(t)) shortening the optimum holding age for cattle and buffalo as farmers substitute mechanical power for animal power.[4] Of course, a rise in fuel prices will have the reverse effect. Expansion of cultivated land, the introduction of new high-yielding inputs (seed, fertilizer irrigation, etc.) and changes in cropping patterns, all may affect the behaviour of the farmer with regard to livestock that, as we suggested earlier, is fully integrated with crop production. Use of additional inputs would raise the marginal product of draft power and, hence, the value of its services. Expansion of cultivated area may have conflicting effects. On the one hand, it necessitates the use of more draft power, on the other it reduces the areas available for pasture.[5] Multiple cropping reduces the optimum holding age in at least three ways: it necessitates mechanization for prompt completion of planting and harvesting to save time for the next crop, it reduces the area of fallow cropland that is used for grazing, and it reduces the amount of underemployed labour in the household and raises its opportunity cost.

[3]Chancellor (1970) reported that the tractor service rates in Thailand decreased at an average rate of 7.2%/year during 1965–69.

[4]Indeed, there is evidence (UNDP/IBRD 1981) that the holding age of the buffalo and cattle is declining. Whereas in earlier years draft animals were marketed at the end of their working life, normally 10 years, in areas where tractors are popular a 5-year turnaround is becoming common.

[5]This may be partly compensated for by the production of more agricultural residues for supplemental feed.

Herd Size and Structure

A change in the optimum holding age of the animal, in turn, affects the age and sex composition of the herd as well as its size. A herd, x, is composed of adult males, m; adult females, f; and calves, c:

$$(2) \quad x = m + f + c$$

Because the primary purpose for which buffalo and cattle are held is draft power, a minimum size of herd will be dictated by the size of the individual farmer's landholding. For draft power, male animals are usually preferred because of their superior strength. Thus, the number of mature male buffalo or cattle, m, held by a farmer depends, to a large extent, on the size and possibly the type of landholding, h, that is:

$$(3) \quad m = kh/\alpha$$

where k = the number of animals in the plowing team (normally one for buffalo and two for cattle), and α = the number of rai (6 rai = 1 ha) that an animal can work (plow, etc.) per year. While α depends on the type of land (paddy or upland, alluvial or sandy, etc.), on average an animal can plow about 1 rai of land each day (4–5 hours/day). De Boer (1972) uses a figure of a total of 720 hours/animal/year. Considering that almost 50% of the Thai farmers own less than 15 rai of land and that only 5% own 60 rai, one mature draft animal should be sufficient for most farmers. However, because of the seasonality and associated urgency of farming activities, such as plowing, planting, and harvesting and the difficulty of plowing certain types of land with a single animal, it is not uncommon to find even relatively small-scale farmers having two draft animals, especially of cattle because they are not as strong as buffalo. An often quoted figure for paddy land in Thailand is 10 rai/buffalo. (Often this is also the figure quoted for rice straw needed to feed buffalo for a year.) Medium-size farms may keep three to four animals, but it is quite rare to find farmers with more than four draft animals. Rather than keeping a large herd of draft animals, large-scale farmers tend to use mechanical power, because they can afford it and because of considerable economies of scale in farm mechanization. Even small-scale farmers, especially in irrigated areas where multiple cropping is possible and grazing land is scarce, have acquired locally made two-wheel tractors. A number of cost comparisons between animal and mechanical power during 1973–74 and 1978–79 seem to favour the latter (Sriboonchitta 1975 and Taenkam 1980), although more recent increases in fuel prices may have changed the picture somewhat. In any case, draft animals are expected to be a major source of both

draft power and meat supplies for the foreseeable future.

Male buffalo and cattle are trained to begin work at 3–4 years of age and continue to serve as draft animals until they reach 10 or 11 years old when they are sold for slaughter. Therefore, draft animals require replacement every 6 or 7 years. Farmers have two options for replacing their animals: they can either purchase calves at the age of 3 and train them for work or they can keep female animals for onfarm breeding. The option they choose would depend on their relative factor endowment and on the market prices for calves. Let us assume that they choose the second option and breed their own calves for replacement. What is the "optimum" number of female breeders? In other words, how many female buffalo or cattle are needed if the farmers' herds of draft animals are to be maintained constant without the need to purchase male calves on the market? The number of breeders, f, needed depends on three factors: the number of male draft animals, m, as determined by equation (3); the frequency of replacement, that is, the number of years the male animal is used for draft, τ_m; and the breeding or, more appropriately, the weaning rate, β, of female animals:

$$(4) \quad f = 2m/\beta\tau_m$$

Once we know the number of female animals, the number of calves (up to 3 years of age) at any point in time will be:

$$(5) \quad c = 3\beta f$$

50% of which are expected to be male and 50% female. Because the number of breeders is determined by the replacement requirements of adult draft animals there will be no shortage or surplus of male calves. However, to avoid shortages and surpluses of female calves a special condition must be met:

$$(6) \quad \tau_f = 1/0.5\beta = 2/\beta$$

where τ_f = the number of years a breeder is held, β = the weaning rate, and 0.5 = the probability of female weaners. In general, the annual surpluses of male and female weaners or calves, z_m and z_f respectively, are given by the following equations:

$$(7) \quad z_m = 0.5\beta f - (m/\tau_m) \quad \text{with } z_m \gtrless 0 \quad \text{for } f \gtrless (2m/\beta\tau_m)$$

$$(8) \quad z_f = 0.5\beta f - (f/\tau_f) = (m/\tau_m)(1 - 2/\beta\tau_f) \quad \text{with } z_f - 0 \quad \text{for } \beta\tau_f - 2$$

That is, a surplus (shortage) of male calves would be generated if the number of breeders is set higher (lower) than the number required for draft male replacements; similarly, a surplus (shortage) of female calves would be generated if female breeders are kept longer (shorter) than $2/\beta$ years. Thus, given a stable herd, a sudden reduction in landholding or increase in either the breeding rate or the "productive" life of draft animals, would lead to a surplus of male weaners as well as adult males. Similarly, a sudden increase in the breeding rate or in the "breeding" life of female animals would lead to a surplus of female weaners. Reverse changes would lead to shortages. Surplus weaners may be sold or fattened and sold for meat a few years later depending on prices and the cost of keeping them. Shortages may be made up through purchases of weaners on the market.

The annual sales of adult male and female animals, s_m and s_f respectively, depend on the size of the herd, its sex structure, and frequency of replacement ("productive" life):

$$(9) \quad s_m = m/\tau_m$$

and

$$(10) \quad s_f = f/\tau_f$$

that is, the larger the herd and the more frequently it is replaced, the larger the number of adult animals sold for slaughter each year.

To sum up, the size, as well as the sex and age structure of a stable herd (or livestock) of buffalo or cattle, whose primary purpose is draft power, are determined by (a) an institution parameter, the size of landholding, h; (b) a biological parameter, the breeding or weaning rate, β; and, (c) an economic parameter, the optimum draft or breeding lifespan of the animal, τ_m or τ_f. Given values for these parameters we can calculate the total size of a stable herd (stock) and its sex and age composition as well as the annual sales for slaughter (flow) using equations (2)–(10).

An example of calculations based on parameters relevant to Thailand is given in Table 3. Note that an increase in the size of landholding brings about a rise in the number of draft males required for plowing and, hence, in the number of breeding females and calves required for replacement. The size of the herd increases proportionately with the size of the landholding (or planted area) and so do the total sales of cull animals, but the average age of the herd remains unchanged.

An increase in the breeding rate, affecting neither the number of draft males nor that of the calves, reduces the number of breeding females needed and, hence, the size of the total herd. The average age of

Table 3. Size, sex, and age structure of a stable herd whose primary purpose is draft power under alternative sets of parameters.

	h = 20 rai				h = 30 rai			
	β = 0.33		β = 0.50		β = 0.33		β = 0.50	
Variables	$\tau_m = 5$	$\tau_m = 6$	$\tau_m = 5$	$\tau_m = 6$	$\tau_m = 5$	$\tau_m = 6$	$\tau_m = 5$	$\tau_m = 6$
Male draft (m)	2.00	2.00	2.00	2.00	3.00	3.00	3.00	3.00
Female breeders (f)	2.40	2.00	1.60	1.33	3.60	3.00	2.40	2.00
Calves (c)	2.40	2.00	2.40	2.00	3.60	3.00	3.60	3.00
Total herd (x)	6.80	6.00	6.00	5.33	10.20	9.00	9.00	8.00
Average age of herd[a]	4.80	5.00	4.20	4.50	4.80	5.00	4.20	4.50
Male cull sales (s_m)	0.40	0.33	0.40	0.33	0.60	0.50	0.60	0.50
Female cull sales (s_f)	0.40	0.33	0.40	0.33	0.60	0.50	0.60	0.50
Total cull sales (s)	0.80	0.66	0.80	0.66	1.20	1.00	1.20	1.00

[a]The average of the herd was calculated on the basis of the following formula:

$$\text{Average age of herd} = \left[\sum_{i=1}^{\tau_m + 3} (m/\tau_m) \cdot i + \sum_{j=1}^{\tau_f + 3} (f/\tau_f) \cdot j \right] /x$$

which for small herds, like the rest of the table "presumes" divisibility of animals (1). Allowing indivisibility, however, would change only the quantitative not the qualitative results. Moreover, this table is more meaningful when the economic unit concerned is the farming community or the sector as a whole in which case the decimals would indicate a fraction of a thousand or a million rather than of a single animal.

Note: h = landholding, β = breeding or weaning rate, τ_m, τ_f = frequency in years of replacement of adult male and female animals, respectively ($\tau_f = 2/\beta$); α = area plowed per animal per year (10 rai); k = number of animals in a plowing team (1 animal).

the herd declines because the number of adult animals (males plus females) is reduced, whereas that of the calves remains unchanged. Sales of cull animals for slaughter are not affected by changes in the breeding rate because in this stable-herd model all the gains from the higher breeding rate are translated into a smaller number of breeders (Table 3).

Finally, an increase in the frequency of replacement of draft animals (reduction in τ_m) leads to an increase in the number of male calves and, hence, breeders (and female calves) needed for replacement, thereby resulting in a larger herd of a younger average age. Cull sales rise (Table 3). Throughout the section we have been treating the frequency of replacement or (productive life) τ as a parameter. However, it is related to the optimum holding age of the animal discussed earlier. In fact, $\tau = t - 3$ because calves are assumed to begin their productive life at the age of 3. Thus, combining Tables 2 and 3 we may conclude that a doubling of both the interest rate and the probability of theft (not an unrealistic scenario for recent years in Thailand) would result in a reduction of the optimum holding age of the draft animals by 1 year and a consequent 13% increase in the size of the herd, a 6% reduction in its average age, and a 20% increase in cull sales for slaughter.

Dual-Purpose Animals, Trade, and Other Complications

Throughout the preceding section we have implicitly assumed the desirability of a constant stock and of single-purpose animals. However, if the primary purpose of raising and holding a stock of buffalo or cattle is draft power, the same amount of draft power may be obtained from a considerably smaller herd by using the female animals kept for breeding as draft animals. With a breeding rate as low as 33%, about two-thirds of the adult females might be available for draft work each year. Assuming further that female draft power is equivalent to two-thirds of the male draft power (in proportion to their respective weights (Chantalakhana, personal communication)), as much as 0.44 units of draft power can be supplied by each female breeder. To the extent that this does not affect the animal's breeding function, 0.44 fewer draft males and correspondingly fewer breeding females and calves for replacement are necessary. For example, if the productive use of animals is for 6 years, each dual-purpose female could reduce the herd by 1.32 animal units. Given the rising opportunity cost of labour and the decline in pastures with the expansion of the cultivated areas, one would expect increased use of female animals for draft. In-

deed this has been the trend (Chantalakhana, personal communication).

A caveat is in order. Thus far we have made no allowance for the indivisibility of the basic animal unit and the inability of a small-scale farmer who raises only a few animals to make marginal adjustments to maintain a stable stock. Our precise estimates presume divisibility of a single animal into smaller units. Allowing for indivisibility through upward or downward adjustment of the fractions to the closest integer would not alter either qualitatively or quantitatively our results for a large herd or for the standing stock of the livestock sector as a whole, because such adjustments are likely to cancel each other out in the end. However, it matters a great deal to smallholders who need 1.5 breeders to maintain their plowing team of two bullocks whether they keep one breeder or two. They are faced with three options: (a) reduction of the frequency of replacement of the bullocks or the breeders or both to attain a stable stock with one breeder, (b) purchase of additional calves for replacement on the market, or (c) maintenance of two breeders and sale of any surplus calves for cash.[6] Which option the farmers choose would depend on the economics of "optimum holding age" as well as on the cost of purchasing calves versus the cost of breeding them.

Where the possibility of exchange does exist, even in a largely subsistence economy, the size of the herd would not be uniquely determined by the farmers' need for draft power. Their relative factor endowment also plays a role. A farmer in Northeast Thailand, having little cash, plenty of underemployed family labour, and free access to communal and forest pastures is likely to produce a surplus of calves for sale by maintaining a larger stock of breeders than is required for the replacement of draft herds. Indeed, a substantial part of the Northeast farmer's cash income is derived from livestock sales. In contrast, a farmer in the Central Plain with more cash and fewer pastures is likely to do little breeding and to purchase at the market most of the needed replacements for the draft herd. Witness the regular outflow of buffalo and cattle herds from the Northeast to the Central Plain and other parts of the country. It is reported that the annual volume of buffalo trade is 24–28% of the standing stock, whereas that of cattle is 30–35% of the standing stock (UNDP/FAO 1975, p. 31). There is also a seasonal aspect to this trade related to crop planting season when draft power is most needed and to the dry season when pastures are poor and overgrazed and, hence, supplemental feed is required.

[6]There is a fourth option, the use of dual-purpose animals as discussed above. This option is ignored here for simplicity of exposition.

A related development is the improved utilization of existing stock through a rental market for draft services. As the availability of pastures diminishes and labour costs and beef values rise, underutilized animals are either sold or rented out and more farmers find it advantageous to rent draft power rather than raise their own animals or shift to mechanical power.[7] The increased incidence of animal theft in Thailand is further contributing to a shift toward mechanical power. On the other hand, the escalation of fuel prices is slowing down the mechanization process.

Implications for Policy

In an attempt to understand the workings of the livestock sector in a rural economy we have developed a model to capture the main threads of the farmer/animal raiser's behaviour and to explain the structure of the current stock when its primary purpose is to supply draft power rather than beef. We have argued that the optimum age at which an animal is sold depends not only on biological parameters, such as growth rate, size and strength, and vulnerability to disease, but also on several economic parameters, such as the farmgate price of live animals, the rate of interest, the value of its services as a draft and/or breeding animal, and the cost of its maintenance (feed, labour, etc.). A change in these variables, will alter the optimum holding age. This will affect not only the age structure of the herd but also its size and sex composition.

Another factor is the choice between various ways of maintaining the desired stock of draft animals: own breeding for replacement, supplementing male draft power through dual-purpose females, and purchasing replacements on the market. These choices depend on biological factors (weaning rate) as well as such economic factors as the availability of cheap family labour, access to pastures, the market prices of male and female calves, etc.

There is always the choice of renting animal labour (separately or in combination with human labour), renting mechanical labour, or purchasing and operating a tractor. These choices introduce more economic variables into the picture: the rental price of animal and mechanical power, the cost of a tractor, and the price of fuel. Several studies in the mid-70s have shown mechanical labour to be economically preferable to animal power despite the

[7]It is estimated that the average planted area per buffalo increased from 7.99 rai during 1960 to 9.24 rai during 1970–79, whereas that of cattle increased from 5.79 rai to 7.49 rai during the same period (Division of Agricultural Economics, various issues).

escalation of fuel prices. However, sociocultural considerations also play a role in the adoption of new technology. Custom and tradition may slow down the adoption of new technology, whereas the influence of neighbours may speed it up. Moreover, the great advantage of animal power lies not just in being economically inexpensive but also in requiring very little outlay of cash, the farmer's most scarce resource.

To what extent can the various parameters on which farmers base their behaviour be used as policy instruments by the government to ensure an "adequate" stock of buffalo and cattle for draft power and an "adequate" supply of animals for domestic beef consumption and exports? Our study has identified the following parameters: the farmer's landholding and access to pastures, the growth and breeding rates of the animals, the probability of loss through theft or disease, the farmgate price of live animals, the interest rate, and the cost of substitute sources of draft power.

The size of landholdings is largely determined by historical and institutional factors as well as by population. Until recently, farmers could increase their landholdings by clearing forest land. This possibility has now been virtually eliminated. Another possibility is to rent land, although land tenancy in Thailand has been relatively limited. To the extent that large-scale farmers prefer mechanical to animal power, the government's ongoing land reform would positively affect the stock of draft animals and negatively affect the chances of developing extensive cattle ranching.

Farmers' access to pastures other than their own fields is localized and limited to few overgrazed communal pastures, dwindling scrub forests, and the roadsides and waterways. The expansion of crop cultivation into the upland areas has reduced available grazing land and open-access to the remaining pastures has resulted in severe overgrazing. It is estimated that stocking rates average about 1.5 animals/ha during the wet season and 0.55 animals/ha during the dry season. Overgrazed pastures lead to low breeding and low growth rates for buffalo and cattle, and could be partly responsible for the stagnation of the sector. Past attempts to increase agronomic productivity have met with only limited success and future prospects in this area are not bright.

The government may introduce new breeds with higher weaning rates and extend them to farmers to cross with local species. For instance, in 1965 the Thai government introduced the American–Brahman that began to be adopted by Thai farmers in the early 1970s. Chantalakhana et al. (undated) report a weaning rate of 0.69 among one-quarter American–Brahman crossbreds. New breeds also help improve the quality of the animal both in terms of strength and in meat production. The Department of Livestock Development has undertaken several projects, but poor nutrition may be partly responsible for the limited effect of improved breeding on overall stocks. There is still scope for breed improvement, especially in the case of buffalo.

Disease and theft control is another area with considerable scope for improvement. High losses through theft or disease reduce the herd and encourage a premature switch to mechanical power. The unhygienic conditions of municipal slaughterhouses and the proliferation of illegal (private) slaughterhouses are largely responsible for the spread of disease and the high incidence of theft. The vaccination program of the Department of Livestock Development is limited because of budgetary constraints. Government-inspected but privately operated slaughterhouses have not materialized yet; if and when they do, buffalo and cattle stocks would benefit through the reduction in disease and theft and improvements in the beef quality and increased exports of live animals.

The farmgate price of live animals can be raised further through more competition among livestock traders and improved marketing. The transport of carcasses instead of live animals would reduce costs and increase the farmgate price of live animals. At present the farmer receives only about 75% of the price paid by the final consumers (Hathamart 1976).

In conclusion, the quantity and quality of beef in Thailand is determined primarily by the need of buffalo and cattle for draft power. This relationship has several implications for the Thai livestock industry: (a) the supply of beef is a by-product of crop farming, and, therefore, not very responsive to consumer demands for meat; (b) the quantity of meat supplied is constrained by the pattern of landholding and the relative shortage of nonforest, nonsmallholding land; and (c) the quality of meat, derived from former draft animals, is unavoidably low. The extensive pasture requirements for a beef-oriented cattle industry are in conflict with the established pattern of landholding, whereas the high risk borne by small-scale farmers raising a few large animals limits expansion of the industry. The small-scale farmer is hampered by the size and indivisibility of the investment and the long gestation period. Adding one more animal to a herd of two is more than a marginal change especially in the context of the overgrazed communal pastures.

Under current conditions little can be done to induce an expansion of the industry. However, buffalo and cattle in a rural economy should be valued not only in terms of their contribution to economic growth but also in terms of their general economic

role. Raising buffalo and cattle is a very effective way of converting underutilized resources (labour and farm wastes) into productive capital, thereby mitigating an otherwise very unequal distribution of income. Still, there is some scope in the form of commercial semi-intensive weaner fattening in feed surplus areas using animals bred by smallholders in the Northeast. Smallholders could also be helped through the breeding and vaccination programs of the Department of Livestock Development. However, future healthy growth of the sector will require a major reform of current regulations governing the marketing of cattle and buffalo.

Acknowledgment

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Discussion Summary

C. MacCormac

This portion of the discussion covered production economics in relation to livestock and the Asian situation in particular. Three approaches to the economics of livestock production were also illustrated. The first presentation, introduced a conceptual model, based on models previously developed and tested in Latin America and Africa, as a means for predicting livestock numbers and supply behaviour as a result of changes in cost and demand conditions for the products and services of livestock. First, very simple models were developed to show the determination of the optimal slaughter age for a male calf for beef only, a female calf for breeding and beef, and a male calf used primarily for draft purposes. Because of the diverse roles of livestock in Asian farming systems, the model was developed further in stages to determine overall cattle profitability, focusing first on draft power and then on milk and beef as the only output. Conditions for profit maximization were determined for males for draft power only and females for breeding only, males for draft power and females for breeding plus milk, and males for draft power plus beef and females for breeding plus beef (milk being valued only for feeding their calves).

Several important characteristics and production effects were highlighted by the author with respect to these different models. In the model where cattle have a draft purpose only, the slaughter age is higher than in the case where the cattle are used for draft and beef. Also, if real costs are incurred to dispose of the animal after its productive life, these costs reduce the value of bullock calves and, therefore, their supply. If this disposal cost can be avoided, there is an external diseconomy and the supply of cattle bred and used for draft power is not reduced. In this model, cows have value essentially for their reproductive capacity, but their costs must be covered by the value of draft services of bullocks. A relatively higher value of draft services would result in an increase in the number of calves. A decrease in cow fertility would reduce bullock use and increase the marginal value of draft services.

In the model where milk has value in addition to draft power, female calves now have a higher profitability. This increases the cow herd and, therefore, the supply of both male and female calves. The price of bullocks falls, their use increases, and farm net income increases. If the value of milk is very high and the feed for cows and bullocks is the same, then the value of total output per unit of feed input increases the price of feed, and, therefore, both owners of cattle for draft or breeding and feed producers will benefit.

In the model where draft power and beef have value (milk being valued for feeding calves only), the first conclusion is that as the price of beef rises, the optimal age of slaughter of bullocks and cows will be lowered. However, this need not result in a smaller herd. In equilibrium, it is expected that total herd size will be larger for draft animals, breeding cows, and replacement animals. Total annual slaughter increases and the average age of the herd declines. An important conclusion of the

model is that with rising beef prices and feed costs, a situation may occur where a bimodal optimal slaughter age occurs whereby profits are equal for calves for beef only and for those for draft or reproduction plus beef at an older age. The proportion of the herd slaughtered for beef only will depend on the relative prices of beef and feed. As the relative price of beef rises (relative to the value of draft services) the use of bullocks for draft purposes becomes an increasingly inefficient use of cattle.

Each of the country papers presented an overview or examples of the economics of livestock production in the country concerned. There were several points common to all papers:

- Livestock play a multipurpose role in beef farming systems and some form of livestock production is found in each major agroclimatic zone of the country;
- Government support for technical research, infrastructure support, and extension services for livestock does not reflect the importance or real value of livestock to the national economy;
- There are only limited social science research programs for livestock, and in some cases there are none at all;
- There is inadequate available data base for time series and cross-sectional analysis of the economics of livestock production; and
- The economic studies that have been conducted to date often show that, based on farm budgeting analysis, maintaining livestock is not profitable.

With respect to priorities for future research, emphasis was placed on obtaining a better understanding of the real economic values farmers place on the costs of livestock, particularly labour and feed, and identifying what benefits the farmers realized from livestock. Greater emphasis should also be placed on research differentiated by important agroclimatic variables.

Discussion of the theoretical model focused on its relevance to the analysis of actual livestock production. Specifically, how did the model account for such constraints as government policies and regulations on slaughter and the availability of labour and capital inputs for production and to what extent would its empirical application be constrained by limitations of data on livestock in Asia? Other questions concerned the variables that could be incorporated and the ability of the model to capture social and cultural aspects of livestock production.

It was agreed that the model was a very useful tool for conceptualizing hypotheses concerning the farmer's decisions to invest in the livestock. Conceptually, the model could incorporate institutional constraints and a wide range of social and economic factors. However, the model quickly becomes increasingly complex in mathematical form as more variables are included. As a result researchers would need to resort to empirical models to test hypotheses suggested by the theoretical model, which is a very powerful tool for conceptualizing a highly complex set of decisions.

Domestic and International Livestock Marketing Issues

Low-Cost Feed Rations: the Prospect for Substitution

Sukanto Lebdosoekojo and Soedomo Reksohadiprodjo[1]

Abstract. In Southeast Asia, increased production of livestock products has been accompanied by a growing reliance on purchased feeds. In this region, production of feed crops by farmers is rare, because all crops produced are used directly for human consumption. Expanding livestock production depends on increased use of crop and agroindustrial residues (CAIR) as feeds. Factors to be considered in the utilization of CAIR are: availability, nutritive values and efficiency of utilization, price, level of technology, and social acceptance. Inclusion of CAIR in a ration is sometimes limited due to high fibre content, presence of antiquality factors, or resulting undesirable animal products. Because of the relatively low prices of many CAIR as compared with conventional feeds, the inclusion of CAIR often results in low-cost rations. However, the economic efficiency of producing and utilizing CAIR on a large scale has to be evaluated. Research needed in this area includes: technology of CAIR conservation and processing, detoxication methods for antiquality factors, technology for increasing nutritive values of straws, and field trial economic evaluations of livestock production utilizing CAIR.

Résumé. Dans le sud-est asiatique, les progrès réalisés dans la production du bétail s'accompagnent d'une dépendance accrue à l'égard des provendes commerciales. Dans cette région, les cultivateurs produisent peu de récoltes fourragères, tous leurs efforts portant sur les produits destinés à la consommation humaine. L'expansion de l'élevage des bestiaux dépend de l'utilisation croissante des résidus de récoltes et de l'agro-industrie en vue de leur alimentation. Les facteurs dont on doit alors tenir compte sont : l'abondance des résidus, leur valeur nutritive, leur efficacité, leur prix, le degré de technologie exigé et leur acceptation pour l'usage prévu. L'utilisation de ces résidus dans les rations sera parfois restreinte par leur teneur élevée en cellulose, par divers facteurs nuisibles à la qualité ou produisant des effets indésirables. En raison des prix relativement bas de plusieurs résidus par rapport aux provendes habituelles, leur adoption permettra souvent d'obtenir des rations moins coûteuses. Cependant, le rendement économique ainsi que la production et l'utilisation à grande échelle de ce genre d'aliments restent à évaluer. Les études devront porter sur les techniques de conservation, les méthodes de détoxication concernant les facteurs antiqualitatifs et celles visant à améliorer la valeur nutritive des pailles ; elles devront s'accompagner d'essais pratiques des possibilités économiques d'élever des bestiaux sur ce genre d'aliments.

Livestock production in most Southeast Asian countries is predominantly operated by smallholders. Livestock are integrated into a farm management system and play important roles in maintaining the agricultural and ecological balance, especially in densely populated regions. Most farmers are not able to use large blocks of land to produce feed crops. Consequently, their animals have to thrive solely on agricultural residues. The growing livestock industries, especially the poultry, swine, and dairy industries, are handicapped by the limited supplies of feedstuffs. The agricultural products are mostly used directly for human consumption, leaving only limited supplies for animal feed. Thus, the livestock industries have to depend on feed from crop and agroindustrial residues (CAIR). In the Western world, especially in the U.S., the livestock industries are supported by either abundant pasture land or abundant supplies of feed grains, largely maize, sorghum, and barley, and high-protein feeds of which soybean and cottonseed are the most important. These conditions are not found in Southeast Asian countries. Therefore, substitutes for corn, soybean, and other feeds should be used as much as possible. Considerations for substitutions that use potential agroindustrial wastes are: availability of the residues, nutritive value and efficiency of rations containing residues, relative prices, levels of technology, and social acceptance.

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Supply of Feed Substitutes

Most feed substitutes are made up of residues and by-products from crop production and agroindustries, including animal and fish production. According to their chemical composition, feed substitutes can be classified into energy feeds, protein feeds, and roughages. The energy feeds, which include CAIR, have less than 20% protein and less than 18% crude fibre or less than 35% cell wall. The protein feeds include products that contain 20% or more protein, and they can be of animal or plant origin. The roughages are usually all products of crop residues, which contain more than 18% crude fibre or more than 35% cell wall (Hartadi et al. 1980).

Potential feed substitutes and estimated production are shown in Table 1. Some of these substitutes have been used extensively for livestock and are referred to as conventional feeds, whereas the ones rarely used are considered as nonconventional feeds. Production of CAIR depends on the production of the parent material, types of processing, and season (Nitis 1981). Not all of the feed substitutes or CAIR are available for livestock. Factors affecting the supply of CAIR for livestock are: people's eating habits, shelf life of the CAIR, dispersion of products, different end uses, and economic factors. For example, groundnut oil cake and almost all parts of slaughtered animals are consumed by humans, which leaves only a small percentage to be used for livestock feed. Some CAIR such as soybean curd sludge, cassava pomace, fish, etc. are perishable, and, therefore, require proper drying and storage.

The farming system used and the size of the industry determine the accumulation of CAIR. Basically, farmers in developing countries are smallholders and the size of home food-processing industries is also small. The CAIR, therefore, are scattered in small quantities throughout villages that may not be in livestock-producing areas. Collection and transport costs may not justify using these products. With a lack of adequate storage facilities the CAIR may be wasted in peak seasons with the result that nothing is left for use in the off seasons. On the other hand, the CAIR produced by large agroindustries and plantations are available for expanding livestock production, because the CAIR are stored awaiting further processing or transport. Competition for use of CAIR as industrial raw material and for export is mainly governed by economic return and government policy.

As an illustration, the total production of rice bran produced in 1977 in Indonesia was distributed as follows: 9% for export, 42.3% for human consumption, and 48.7% for animal feed. For cassava, the distribution was: 4.1% for export, 1.7% for industry, and 82.7% for human consumption, with 9.6% wastage in fields and 1.9% for animal feed (BPS 1979).

Demand for Feed Substitutes

Livestock and feed producers select feed substitutes based on supply, nutritive value, price, and physical characteristics of the feeds. Of these, the nutritive value and the price are the most important factors.

Supply

Ease of access to reliable ongoing supply, in quantity as well as in quality, is one of the considerations taken by livestock and feed producers to use CAIR. The lack of grading and quality control of CAIR result in difficulty for the commercial producers when using CAIR in large amounts in feed formulation.

Nutritive Value

Nutritive values of CAIR are not static. In numerous studies variations between the reported nutritive values of CAIR are common. The values depend on the chemical composition of the parent materials, the type of processing, and the adequacy of storage. Adulteration of products during processing or marketing may greatly influence the nutritive value.

Crop residues are mostly classified as roughages that are high in lignocellulosic components, low in protein, and low in digestibility. The primary uses are as energy sources in ruminant rations. Leaf meals, such as *Leucaena*, *Gliricidia*, and *Sesbania*, which are produced as by-products of some plantations, are considered to be plant protein sources for ruminants. The agroindustrial residues and by-products are usually higher in nutritive value than crop residues. The energy content calculated in total digestible nutrients (TDN) of energy feeds ranges from 43 to 91%. The crude protein (CP) content from plant protein sources ranges from 19 to 41% and the CP of animal protein ranges from 50 to 60% (Table 1).

Total essential amino acids from the animal protein sources are generally higher than those from plant protein sources. Soybean seed residues contain higher total essential amino acids than the other plant proteins except for copra meal, which contains more arginine. The availability of amino acids in plant protein varies from 61.0 to 89.1%, which is slightly lower than animal protein sources (72.0–88.7%). In soybean meal, the availability of amino acids is almost the same as in fish meal (Nitis 1981).

Table 1. Estimated production and crude protein and energy (TDN) content of crop and agroindustrial residues in Indonesia, dry matter basis.[a]

Product	Quantity ('000 t/year)	Crude protein (%)	Total digestible nutrients (%)
Energy feeds			
Conventional			
Rice bran	2577	10.7	81.0
Maize bran	403	14.2	90.9
Molasses	343	1.8	53.0
Nonconventional			
Cassava pomace	157	2.6	89.1
Cassava peelings	5000	3.3	60.7
Gnetum gnemon pulp	na[b]	17.4	40.1
Coffee pulp	89	18.9	47.6
Citrus pulp	6	6.5	43.6
Cocoa husk	1.5	7.4	46.5
Pineapple bran	0.05	3.5	72.0
Banana fruit waste	22.4	6.1	62.8
Protein feeds			
Conventional			
Copra meal	344	21.6	69.3
Peanut meal	11	40.6	52.3
Palm kernel meal	2.2	22.2	58.5
Trash fish and wastes (fish meal)	355[c]	61.9	69.0
Nonconventional			
Kapok meal	na	32.8	41.6
Rubber seed	na	18.8	62.0
Leucaena seed	na	31.3	59.5
Soybean curd sludge	na	31.4	52.6
Soysauce sludge	na	27.8	80.5
Cassava leaf meal	1410	22.0	57.8
Leucaena leaf meal	na	22.3	72.5
Sesbania leaf meal	na	25.8	63.0
Snail meal	na	51.2	65.1
Roughages			
Conventional			
Peanut vines	1025	13.9	67.2
Maize stalk	19745	6.5	46.6
Sorghum stalk	na	6.5	41.4
Sugarcane tops	174.8	5.4	46.6
Nonconventional			
Rice straw	34215	5.5	26.6
Soybean straw	na	7.7	50.7
Sweet potato leaf	555	14.6	72.4
Bagasse	1717.3	2.0	49.4
Sago wastes	na	1.8	19.5

[a]Production figures calculated from BPS (1979); average reported values for crude protein and total digestible nutrients content from Gohl (1975) and Hartadi et al. (1980).
[b]Not available.
[c]Kompiang (1981), wet basis.

No one CAIR contains sufficient nutrients or the proper balance to satisfy the total requirements of any animal. Therefore, CAIR cannot be used as the sole source of nutrients in rations. They should be mixed with other feed stuffs or other residues to balance the amino acid and energy requirements for specific kinds of livestock. The maximum desirable level of inclusion of CAIR in rations will vary among residues and among animal species (Table 2). The limiting factors may be due to high fibre content,

Table 2. Maximum inclusion levels of crop and agro-industrial residues in rations.

Product	% dry matter in rations		
	Poultry	Swine	Cattle
Rice bran	40	60	40
Maize bran	40	60	40
Molasses	5	15	15
Cassava pomace	25	30	40
Coffee pulp	20	20	na
Citrus pulp	10	na	na
Cocoa husk	na[a]	35	30
Copra meal	40	50	60
Peanut meal	na	na	na
Palm kernel meal	20	30	na
Kapok meal	10	10	na
Rubber seeds	5	na	na
Leucaena seeds	10	na	na
Cassava leaf meal	5	50	60
Leucaena leaf meal	5	50	60
Peanut vines	—[b]	—	80
Maize stalk	—	—	80
Sorghum stalk	—	—	30
Rice straw	—	—	50
Bagasse	—	—	40
Sugarcane tops	—	—	80

[a]Not available.
[b]Dashes refer to information that is not applicable because the product is normally used for ruminants.
Source: Gohl (1975); Devendra (1981b); Nitis (1981).

such as leaf meals; the amount of toxic substances, such as cocoa husk (theobromine), kapok seed (cyclopropenoic acid), rubber seed (cyanogenic glucosides), etc.; or resulting undesirable products such as fish meal (fishy flavour), copra meal (firm fat), etc. (Gohl 1975).

Nutritive values can be improved by chemical treatments. Experiments on the improvement of straws have been conducted since 1900, using alkali, acid, urea, etc. Sodium hydroxide treatment is the most promising one (Jackson 1978; Jayasuriya 1979a; Budhi et al. 1981). However, chemicals are usually too expensive for farmers to use. Recent research, using microorganisms to degrade lignocellulose and to increase protein content, has been conducted with success in laboratories (Prins 1979; Sancayaningsih et al. 1981). Research to increase the levels of rice bran in poultry rations by reducing the antiquality factor has also been conducted (Kratzer and Payne 1977; Soeharto and Nasrudin 1980). Research on the elimination or reduction of antiquality factors in oil meals has good prospects as well.

Price

The value of CAIR used as a feed substitute can be looked upon as the actual price in the market or as its "comparative price," namely the value of the substitute as compared with the price of conventional feeds based on equal nutrient content. Table 3 presents average actual prices of CAIR in Java in 1979 and the comparative prices based on the prices of maize and soybean oil with equal CP and TDN. The data indicate that most of the comparative prices of CAIR are higher than the actual prices, except for molasses, peanut meal, and fish meal. The reasons are that molasses is used for alcohol production, peanut meal is consumed by humans, and fish meal has a superior amino acid composition and is, therefore, in demand for nonruminant animals. Based on the comparative prices, diets containing mostly CAIR are cheaper to use if calculated in terms of nutrient content than those based directly on maize and soybean oil meal.

The reported economic evaluations of CAIR diets are not always complete. Rations containing CAIR often entail additional costs to cover handling, bulkiness, purchase of supplements, etc. In some instances, higher levels of CAIR may result in lower animal performance or production, but the cost may be low enough to reduce feed cost per unit of production (Budhi et al. 1981).

Physical Characteristics

The differences in physical characteristics of CAIR from those of conventional feeds is that they require adjustment in equipment and machinery. For example, the bulkiness of CAIR may require more storage and additional handling facilities. It may also alter the feed intake of the animals.

Table 3. Price comparison of commercially available crop and agroindustrial residues in Java, 1979.

Product	Actual price (Rp/kg)[a]	Relative price (Rp/kg)[b]
Rice bran	40.23	92.45
Maize bran	45.00	115.89
Molasses	70.00	31.58
Cassava pomace	42.70	50.78
Cassava peelings	15.00	42.82
Gnetum gnemon pulp	116.00	164.49
Copra meal	104.45	147.39
Peanut meal	284.19	248.14
Palm kernel meal	111.00	148.35
Kapok meal	27.00	204.19
Soybean curd sludge	97.00	196.77
Leucaena leaf meal	101.74	154.02
Fish meal	389.00	373.97

[a]Average price in Java, dry matter basis.
[b]The relative price was computed on a nutrient content basis with the nutrients (CP and TDN) given the same value as their cost in maize at Rp 90.00/kg and soybean oil meal at Rp 300.00/kg.
Note: Rp 645.00 = U.S.$1.00.

Prospects

APHCA–IFI (1980), a feed industry group, has considered the importance of nonconventional feeds as substitutes in livestock and poultry rations and has recommended that more information be generated on the nutritive value of nonconventional feeds, that an increased variety of feedstuffs be used, and that there be more development of the feed industries that use nonconventional feeds. The livestock producers recommended that field trial evaluations be conducted to determine the economic and technical feasibility of using nonconventional feeds for livestock rations.

Under present conditions in Indonesia, the maximum utilization of CAIR as a cheap source of feed ingredient depends on the pressure for additional feed, levels of technology, and economic conditions. The need for protein feeds and roughages is apparent.

Because there is a sufficient supply of rice bran, it is important to maximize rice bran inclusion in rations. Cassava pomace requires drying for use in feeds. Thus, cheap drying methods for such products need to be developed. Rice straw occupies an important role in roughage research because of the abundant supplies in villages and the limited land areas available for growing forages, especially in Java. Among the nonconventional protein sources, kapok seed, rubber seed, *leucaena* seed, and leaf meals have potential if technology can be developed to reduce the antiquality factors at a cost within the reach of livestock producers. Technology to conserve trash fish and fish waste is essential to increase supplies of low-cost animal protein.

Research in the utilization of CAIR under local conditions that has been conducted includes nutritive evaluations and some feeding trials (Soedomo et al. 1980; Soeharto and Nasrudin 1980; Budhi et al. 1981). Further research needed to obtain low-cost feed substitutes and ensure their efficient use includes: conservation processing and drying technology, detoxication methods for reducing antiquality factors, technology for increasing feeding values of straws, and field trials for economic evaluation of CAIR use. Exchanges of information among technologists, animal scientists, and economists are essential to realize the full potential of CAIR in low-cost rations.

Changing Consumption Patterns for Livestock Products: Korea and Japan

Suk-Jin Cho[1]

Abstract. Changes in the consumption pattern for livestock products in Korea are discussed using time-series data and the numerical results of demand analysis for both Korea and Japan. The evidence implies that the consumer demand for livestock products in Korea will increase as per-capita real income grows. This observation is particularly true for beef and dairy products. In addition to income and price, consumer preference seems to play a very important role in determining beef consumption as compared with other livestock products. The strongest substitute for beef in Korea is fish followed by chicken and pork. This implies that the short-term pricing policy aimed at turning excess demand for beef to pork is not practical. Increases in per-capita consumption of pork, chicken, and eggs in Korea seem to have been stimulated more by continuous declines in real prices rather than rises in income, whereas the opposite is true for beef and dairy products. Gradual changes in eating habits from rice-and-fish to bread-and-meat will be hastened in Korea as the younger generation becomes accustomed to eating more livestock products. Appropriate longer-term measures must be established to deal more effectively with the changes in consumption patterns.

Résumé. Discussion des modifications constatées en Corée dans la consommation des produits du bétail, à partir d'indicateurs chronologiques et des chiffres obtenus de l'analyse de la demande en Corée et au Japon. Il ressort de ces témoignages que la demande des produits du bétail en Corée devrait augmenter de pair avec l'amélioration du revenu réel des particuliers. L'observation s'applique surtout à la viande de bœuf et aux produits laitiers. Outre la question des revenus et des prix, il semble que les préférences de la population aient une influence marquée sur la consommation de la viande de bœuf comparativement à d'autres produits du bétail. Les denrées principales qui remplacent la viande de bœuf en Corée sont d'abord le poisson, suivi dans l'ordre par le poulet et le porc. La politique envisagée de fixer à court terme les prix de façon à transférer au porc l'excédent de la demande de bœuf ne semblerait donc pas être pratique. L'augmentation de la consommation individuelle de porc, de poulet et d'œufs, en Corée, semble avoir été stimulée plutôt par une baisse constante des prix réels que par l'amélioration des revenus, tandis que le contraire est vrai pour la viande de bœuf et les produits laitiers. Les modifications progressives des habitudes alimentaires et le passage du riz et du poisson au pain et à la viande devraient s'accélérer à mesure que la jeune génération des Coréens s'habituera à consommer plus de produits du bétail. Il faut donc prévoir, à plus longue échéance, les mesures appropriées qui permettront de faire face avec plus d'efficacité à l'évolution des habitudes alimentaires.

As income grows so does the per-capita consumption of livestock products, and food preferences change in a reasonably predictable way. The demand for livestock products is also influenced by price changes, especially when the prices of other foods diverge from those of livestock products. In addition to such economic factors, there are also the effects of changes in tastes and preferences for livestock products. However, unlike income or prices taste defies direct measurement. In demand analysis, a change in taste or preference is sometimes employed as a catchall for that portion of demand not explicitly measurable by economic variables in a manner analogous to that of technical change in production economics.

Consumer demand for a given preference ordering, implies that the form of utility function from which this demand is derived is given a priori. In this respect, taste is a dynamic concept, whereas the demand for a specific commodity is static. Consequently, changes in taste or preference lead to a shift of demand curves. Changes in taste can occur either from external influences or from past decisions made by the consumer. Taste changes of these types are subject to environmental conditions such as custom,

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culture, habits, religion, age, and other factors specific to a particular society. Changes in taste may be masked by increases in income resulting from economic development. To the extent that taste changes are related to income, international comparisons may be helpful in forecasting a country's future pattern of demand after accounting for differences in culture. Useful information can be derived concerning the consumption patterns at different stages of economic development; however, there is no assurance that different countries will follow the same path.

To overcome differences in culture and secure a homogeneous sample while investigating the relationship between income and the consumption of livestock products, use is made of time-series data and the numerical results of demand analysis in Korea and Japan. Japan has been chosen for comparison because of its geographic and cultural similarities to Korea. Traditionally, the two countries have many things in common, including similar resource endowment (high population to land ratio), climate, and eating habits (rice-and-fish). The most distinguishable difference between the two countries is in their respective stages of economic development, which significantly influences the consumption of livestock products. A comparison of consumption trends is useful in predicting future developments not only for Korea but for other Asian countries as well.

Changes in Real Income and Consumption of Livestock Products

Time-series data illustrating the historical relationship between the consumption of livestock products and real income are summarized in Table 1 for both Korea and Japan. With the exception of eggs in the case of Japan, per-capita consumption of livestock products in both countries shows a sustained increase, for 1970–75. In the case of meat, the consumption level in Korea lags 10 years behind Japan, presumably because of differences in income levels. (Per-capita real gross national product (GNP) in Korea amounts to about one-eighth of the level in Japan during the period covered in the study.)

Aside from income, prices also play a very important role in the short-term. Table 2 lists the indexes of real prices for livestock products in both countries. When variations in price are taken into account, the high annual growth in Korean per-capita consumption of pork and chicken over 1975–80 appears to be due to the decline in real prices. The same is true for pork and chicken in Japan over the period 1960–70. The real price of beef has continuously increased in both countries, implying that the moderate annual growth in consumption is due to the rise in real per-capita income during the period.

So far as other livestock products are concerned, per-capita consumption of eggs in Korea is much lower than in Japan, where it seems to have reached a saturation point, given the decline experienced between 1970 and 1975. The real price of eggs in Japan declined continuously between 1955 and 1975 and stimulated consumption. Without this decline in price egg consumption would have leveled off earlier. Given that current Korean consumption is comparable to that of Japan in 1960 and that the real price has also been declining continuously, per-capita egg consumption in Korea appears likely to grow in future.

Of all livestock products shown in Table 1, the difference in the consumption of dairy products is most evident. However, the annual growth in the consumption of dairy products is higher in Korea at almost four times the rate of increase in real GNP per capita. The consumption of dairy products is closely related to income in both countries, and in Korea in 1980 it was comparable to that of Japan from as early as 1955. In Japan, the price of milk has been quite stable, but in Korea it has undergone considerable fluctuations similar to those of pork and chicken. In spite of the upward fluctuations of milk prices in Korea, it has experienced a higher annual growth rate in consumption implying that growth in real income has played a very important role. In Japan, the consumption of fluid milk leveled off in the 1970s, probably due to the sharp drop in the price of orange juice, a substitute for milk. A similar occurrence is possible in Korea depending upon the appearance of substitutes for fluid milk.

Consumption of such high-quality dairy products as butter and cheese will remain negligible in Korea until real income increases. Because the present consumption of dairy products in Korea is only 20% of Japan's in 1975, Korean per-capita consumption will increase, although the very high annual growth rate experienced to date may decline gradually.

The results of the comparison of time-series data imply that in both countries the consumption of beef and dairy products is more sensitive to the changes in real income than price, whereas the reverse seems true for pork, chicken, and eggs. The lower consumption of eggs and dairy products in Korea seems to reflect the considerable difference in real income between the two countries. On the other hand, the difference in per-capita consumption of meat looks less conspicuous than that of eggs and dairy products. This is particularly true in the case of beef because consumption is almost the same in the two countries, which suggests that consumer preference for beef in Korea is relatively stronger than in Japan.

Table 1. Annual per-capita (kg) consumption of livestock products in Korea and Japan.[a]

	Korea				Japan				
	1965	1970	1975	1980	1955	1960	1965	1970	1975
Meat	3.4	5.2 (8.9)[b]	6.4 (4.2)	11.3 (12.0)	2.1	3.0 (7.4)	6.0 (14.9)	10.5 (11.8)	14.2 (6.2)
Beef	1.0	1.2 (3.7)	2.0 (10.8)	2.6 (5.4)	1.1	1.1 (0.0)	1.4 (4.9)	2.0 (7.4)	2.5 (4.6)
Pork	2.0	2.6 (5.4)	2.8 (1.5)	6.3 (17.6)	0.7	1.1 (9.5)	2.7 (19.7)	4.7 (11.7)	6.5 (6.7)
Chicken	0.5	1.4 (22.9)	1.6 (2.7)	2.4 (8.4)	0.3	0.8 (21.7)	1.9 (18.9)	3.8 (14.9)	5.2 (6.5)
Eggs	1.6	4.1 (20.7)	4.5 (1.9)	6.4 (7.3)	3.7	6.3 (11.2)	11.6 (13.0)	14.8 (5.0)	14.0 (−1.1)
Dairy products	0.3	1.4 (36.1)	4.6 (26.9)	10.8 (18.6)	12.1	22.3 (13.0)	37.4 (10.9)	50.1 (6.0)	53.3 (1.2)
Per-capita GNP 1975 (U.S.$)	280	408 (7.8)	574 (7.1)	754 (5.6)	977	1430 (7.9)	2201 (9.0)	3685 (10.9)	4370 (3.5)

[a]Data for dairy products are converted into milk equivalent.

[b]Data within parentheses are annual growth rates over the preceding 5 years.

Source: Per-capita consumption data for Korea are from "Materials on price, demand and supply for livestock products 1981" (National Livestock Cooperatives Federation). The data for Japan are from "Kaitei Nihon Nogyo Kisotokei" (Association of Statistics for Agriculture and Forestry, Tokyo, 1977). Data for per-capita GNP are from "Handbook of Korean economy 1980" and "Major statistics of Korean economy 1981" (Economic Planning Board of Korea).

Table 2. Indexes of real prices of livestock products (base year, 1970 = 100).[a]

	Korea				Japan			
	1965	1970	1975	1980	1960	1965	1970	1973
Meat	86	100	109	132	106	102	100	100
Beef	66	100	111	162	72	79	100	121
Pork	88	100	128	118	106	103	100	99
Chicken	na[b]	100	119	107	139	118	100	96
Eggs	127	100	95	70	161	132	100	94
Dairy products	111	100	120	117	101	105	100	102

[a]The prices of dairy products correspond to that of fresh milk in both countries.

[b]Not available.

Source: The data for Korea are from "Materials on price, demand and supply for livestock products 1981" (National Livestock Cooperatives Federation) and "Economic statistics yearbook 1981" (Bank of Korea). The data for Japan are from Sanderson (1978).

A plot of the relationship between per-capita consumption of livestock products and real income shows that meat consumption as a whole increases on a straight line; that egg consumption still increases but at a decreasing rate in Korea and begins to decline in Japan; and that dairy consumption increases sharply in Korea, but at a decreasing rate in Japan.

Results of the Food Demand Analysis

In a developing country with growing per-capita income, consumer preferences for food gradually change in both quantity and quality. This change in private consumption expenditures is determined mainly by income and prices. The price of food is, politically, a very sensitive issue in most developing countries. Thus, government policies are established under various conditions of shortage or glut depending upon the responsiveness of consumer demand to price changes. The results of quantitative demand analysis can provide useful information in decision-making for policymakers. In this respect, it is instructive to compare the results of demand analyses performed in both Korea and Japan. Furthermore, a comparison of results will shed more light on the observations made in the preceding section.

Results obtained by the author in Korea and by Sae and Sasaki (1973) for Japan will be compared with emphasis on income elasticity, price elasticity, and Frisch's (1959) money flexibility (income elasticity of marginal utility of income). The empirical model used in both studies is Powell's (1966) demand system, which can be considered a simplified version of Stone's (1954) linear expenditure system. For the estimation, commodities are categorized in 12 subgroups in Korea and 10 subgroups in Japan, with the emphasis on food so that the assumption of preference independence can be fully accounted for. Data are from the "Annual Report on the Family Income and Expenditure Survey" regularly tabulated for urban households over 1966–79 in Korea and over 1958–68 in Japan. In both studies price series are obtained by deflating consumer price indices by the consumer price index of all items, amounts purchased are per-capita average expenditures per month deflated by the price indices of corresponding subgroups, and income or total expenditure is defined as the sum of all products including price and quantity.

The most important results obtained in both studies are summarized in Table 3. Before making detailed comparisons, it is important to note values for Frisch's money flexibility of -2.07 for Korea and -2.09 for Japan. These values, according to Frisch, are appropriate for the middle-income bracket or the median part of the population. The results, obtained from the midpoint of the time period in both studies, imply that the living standard in 1973 in Korea is roughly comparable to that of Japan in 1963. Furthermore, the fact that the values of money flexibility estimated in both countries are equal, makes the comparison of consumption patterns more meaningful.

In Table 3, income elasticity of demand for cereals, which means rice in Japan and rice and other grains in Korea, turned out to be negative in the former and 0.374 in the latter. For fish, the value of income elasticity appeared to be lowest of all other food types in both countries but higher in Korea than in Japan. These facts imply that the conventional diet, characterized by rice-and-fish in both countries is changing. Income elasticity for meat, milk, and eggs seems to reflect that they are a priori as one would expect. The income elasticity for meat falls short of that for milk and eggs in Korea, whereas the reverse is true in Japan. In both countries income

elasticity for vegetables is less than unity but higher in Korea than Japan. For fruits, however, income elasticity is 1.405 in Korea and 1.386 in Japan. For outside meals, income elasticity in Korea of 1.921 far exceeds the value of 1.232 in Japan. Finally, for nonfood items, there is no significant difference between the two countries. On the whole, values of income elasticity in both countries reveal similar trends. Foods such as cereals, fish, and vegetables are necessities, whereas livestock products, fruit, and outside meals turn out to be luxuries. All price elasticities in both countries appear inelastic except for alcoholic beverages in Korea.

Contrary to the general belief that the income elasticity for food in most countries is less than unity, the results in Table 3 show that many food items exceed unity in many cases. (Heidhues (1977) suggests that the income elasticity for food extends from about 0.9 at the preindustrial stage to 0.1 for the mature stage of economic development.) This is particularly evident for livestock products in both countries.

Although analyses of the demand for food in Korea and Japan indicate that income elasticity for livestock products far exceeds unity, more detailed information is needed regarding income and price elasticities for specific livestock products. In an effort to delve further into the consumer's behavioural patterns, a comparison will be made of the numerical results of meat demand analyses performed by the author in Korea and by Sawada (1980) in Japan. Both studies adopt Theil's (1975) Rotterdam demand model with the assumption of "Block Independence," which is also known as the case of strong separability. The data base used in both studies is the same as that used in food demand analyses in Table 3 and the time periods covered are 12 years (1969–80) in Korea and 15 years (1956–70) in Japan. The results of both studies are summarized in Table 4. Fish is included in addition to beef, pork, and chicken, because fish is still a strong substitute for meat in both Korea and Japan accounting for almost 43% and 60%, respectively, of total expenditure on meat and fish. Thus, parameters estimated without fish are possibly biased.

In Table 4, two kinds of income elasticities are listed. The conditional income elasticity stands for percentage change in the demands for meat (includes fish hereafter) when the expenditure for meat increases by 1%, and the nonconditional income elasticity corresponds to the value of income elasticity in the usual sense. Values of income elasticity for three particular meats: beef, pork, and chicken, exceed unity either in the conditional or nonconditional case, but the values for fish are lower than unity in both countries. The magnitudes of income elasticity in both countries are of the same order, with the highest values for chicken followed by beef, pork, and fish. For beef, pork, and fish the values of income elasticity are higher in Korea than in Japan, and the reverse is true for chicken. Similar trends are observed for price elasticities, the magnitudes of which are larger than the income elasticities except for beef in Korea. Therefore, consumers in both countries

Table 3. Results of food demand analysis.[a]

Item	Marginal budget shares		Price elasticity		Income elasticity	
	Korea	Japan	Korea	Japan	Korea	Japan
Cereals	0.067	−0.043	−0.216	0.334	0.374	−0.569
Cereals except for rice	—	0.007	—	−0.187	—	0.369
Meat	0.049	0.051	−0.618	−0.761	1.398	1.525
Milk and eggs	0.024	0.042	−0.744	−0.688	1.725	1.375
Fish	0.012	0.004[b]	−0.160	−0.057	0.352	0.109
Vegetables	0.041	0.004[b]	−0.351	−0.075	0.756	0.145
Fruit	0.023	0.027	−0.610	−0.688	1.405	1.386
Condiment	0.020	—	−0.264	—	0.582	—
Processed food	0.004[b]	—	−0.116	—	0.263	—
Confectionary and soft drinks	0.020	—	−0.502	—	1.152	—
Alcoholic beverage	0.020	—	−1.028	—	2.405	—
Outside meal	0.019	0.035	−0.825	−0.618	1.921	1.232
Other foods	—	0.096	—	−0.474	—	0.851
Nonfood	0.702	0.776	−0.855	−0.915	1.202	1.267

[a]The subgroup "other foods" in Japan includes condiments, processed foods, confectionary and soft drinks, and alcoholic beverages.
[b]Marginal budget shares are statistically not significant at the 5% level.
Source: Sae and Sasaki 1973; Cho 1981.

Table 4. Numerical results of meat demand analysis.

	Beef	Pork	Chicken	Fish
Korea				
Income elasticity				
Conditional	1.26	1.08	1.40	0.75
Nonconditional	1.38	1.19	1.54	0.83
Conditional budget share (%)				
1969	31	13	6	50
1980	33	15	9	43
	(0.6)[a]	(1.3)	(3.8)	(−1.4)
Price elasticity				
Beef	−1.34	0.09	0.06[b]	0.56
Pork	0.19	−1.53	0.36	0.45
Chicken	0.24	0.66	−1.64	0.04[b]
Fish	0.36	0.13	0.01[b]	−0.87
Japan				
Income elasticity				
Conditional	1.88	1.76[b]	2.84	0.42[b]
Nonconditional	1.09	1.02[b]	1.64	0.24[b]
Conditional budget share (%)				
1956	18	8	3	71
1970	13	18	9	60
	(−2.3)	(6.0)	(8.2)	(−1.2)
Price elasticity				
Beef	−1.38	0.51	0.14	0.05[b]
Pork	0.61	−1.81	0.23	0.35[b]
Chicken	0.40	0.53	−2.18	0.26[b]
Fish	0.01[b]	0.08[b]	0.03[b]	−0.27

[a]Data within parentheses are annual growth rates over the time span.
[b]The directly estimated parameters from which the values are indirectly derived lack statistical significance at the 5% level.
Source: The results in Korea are by the author's calculations and the results in Japan are by Sawada (1980).

show more sensitive responses to changes in price than income in the consumption of meat, except for beef in Korea.

On the other hand, the conditional budget shares in Table 4, show that values for fish in both countries and beef in Japan decreased over the period in question. The annual growth rate for chicken was highest at 3.8% in Korea and 8.2% in Japan. The most conspicuous difference between the two countries was in the conditional budget shares for beef and pork. For pork, conditional budget shares in both countries increased, but the annual growth rate is far higher in Japan reflecting continuous price declines in the latter as shown in Table 2. For beef, however, the negative annual growth rate in Japan is quite the opposite to what was experienced in Korea. Of course, this phenomenon can be explained theoretically in terms of the high price elasticity in Table 4 and the continuous price increase for beef in Japan. The conditions are almost the same in Korea, with a high price elasticity for beef and continuous increases in price and per-capita real income over the period in question. The above facts imply that consumer preference for beef in Korea is much more tenacious than in Japan. Furthermore, the results can be construed as indicating that substitution between beef and pork is more plausible in Japan than in Korea. This observation can be verified from the cross price elasticities in Table 4. In Korea, the most powerful substitute for beef is fish followed by chicken and pork. The situation is, however, somewhat different in Japan; pork is the strongest substitute for beef followed by chicken and fish.

The information on cross price elasticities in Table 4 is directly relevant to making decisions on short-term price policy, particularly when a decision must be made on how large the price gap should be between beef and pork to transfer excess demand from beef to pork.

Except for fish, all meat is still considered a luxury in both countries. However, the conditional budget share for fish depicts similar downward trends in both countries, thereby implying the gradual decline in fish consumption. Such taste changes seem to be further hastened by the younger generation of consumers who are accustomed to a bread-and-meat rather than a rice-and-fish diet. Consequently, government policy to adjust to such major changes in

taste has to be established with a view to avoiding short-term, stopgap measures. Especially in Korea where the domestic supply of beef has fallen short of demand in recent years, this problem has to be studied by the authorities as well as by researchers to solve the problem at its source rather than simply resorting to such short-term measures as importing beef to satisfy the excess demand.

Implications and Suggestions for Further Study

On the whole, the evidence obtained in this study implies that consumer demand for livestock products in Korea will increase as per-capita real income grows. This is particularly true for beef and dairy products. In terms of per-capita consumption, the gap between Korea and Japan is almost negligible for beef, but substantial differences are evident for dairy products followed by eggs, chicken, and pork. Given the great disparity in per-capita real income between both countries, and assuming that the consumption pattern in Korea follows a similar path as that experienced in Japan, the implications for the consumer demand for livestock products in Korea can be summarized as follows:

- Consumer preference in Korea seems to play an important role in the consumption of beef compared with Japan or with the consumption of other livestock products in Korea;
- The most important substitute for beef in Korea is fish followed by chicken and pork, a pattern that implies that the short-term price policy of turning excess demand for beef to pork is not practical;
- Increases in per-capita consumption of pork, chicken, and eggs in Korea seem to have been stimulated more by continuous price declines than by an increase in per-capita real income; the opposite is true for beef and dairy products. Because Korean production of pork, chicken, and eggs is heavily dependent on imported commercial feeds steep increases in the international prices of feed grains can have negative effects on the demand for these commodities. Furthermore, increases in the relative prices of these items can raise the demand for beef temporarily aggravating the balance between domestic production and the demand for beef in Korea; and
- Changes in eating habits from a rice-and-fish to a bread-and-meat diet will be further hastened as the younger generation becomes accustomed to eating more livestock products. To deal with such changes in consumer tastes, appropriate longer-term measures have to be taken and stopgap solutions should be avoided.

Finally, the results in this study emphasize the need to undertake further research. First, more studies are needed to develop a reliable empirical model to predict the consumption of livestock products over a decade. Studies of supply are also necessary to investigate producer behaviour patterns including their response to price variations at both the micro and macro levels. In addition to studies on demand and supply, studies to clarify the prospect for the domestic production of feedstuffs, particularly in relation to the production of food grains, are badly needed. In most Asian countries with a high population to land ratio, the level of domestic production of feedstuffs creates a bottleneck in determining the desired level of self-sufficiency for livestock products. This is especially true when the price of feedstuffs in international markets is volatile. Related studies on price policy, marketing, processing, and storage for livestock products are also necessary.

Livestock: Policy Issues in Trade, Pricing, and Marketing

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Abstract. In their efforts to meet increasing consumer demand for livestock products, Asian governments face difficult policy choices: domestic production vs. imports, producer vs. consumer welfare, fiscal restraint vs. budget subsidies, and public intervention vs. market forces. The paper discusses policy tradeoffs and concludes that: (a) Regardless of comparative advantages, all governments try to increase the share of domestic production in total consumption. If the objective is to close the gap between urban and rural incomes such import substitution policies could be supported on social grounds; (b) Mostly, the interests of urban consumers prevail over those of rural producers. Often, therefore, price controls are introduced. However, if governments fail to ensure sufficient market supplies to meet the demand at controlled prices, price controls are ineffective and cause problems; (c) So as not to excessively depress producer prices, governments frequently subsidize domestic production to increase market supplies, rather than increase imports. However, such subsidies favour higher-income groups and, therefore, have dubious social value; and (d) Governments at times choose to intervene directly in the market by establishing public marketing agencies, especially in the dairy sector. But experience with government marketing agencies has not been encouraging throughout the developing world. The paper recommends measures to improve the efficiency and competitiveness of marketing systems, thereby benefiting producers and consumers alike.

Résumé. En s'efforçant de combler la demande croissante des consommateurs pour les produits du bétail, les gouvernements asiatiques ont à faire des choix difficiles dans leurs orientations : production nationale ou importations, intérêts du producteur ou du consommateur, restrictions fiscales ou subventions budgétaires, interventions publiques ou liberté des marchés. Cette étude analyse les possibilités de compromis entre ces diverses orientations et tire les conclusions suivantes : (a) Quels que soient les avantages comparatifs, tous les gouvernements tendent à accroître la part de la production nationale dans la consommation globale. Si l'objectif est de réduire l'écart entre les revenus urbains et ruraux, la politique de substitution des importations pourrait se justifier au point de vue social. (b) De façon générale, ce sont les intérêts des consommateurs urbains qui l'emportent sur ceux des producteurs ruraux. C'est pourquoi l'on recourt souvent au contrôle des prix. Toutefois, si les pouvoirs publics ne peuvent alimenter les marchés en quantités répondant à la demande, à des prix contrôlés, ces contrôles deviennent inopérants et causent des problèmes. (c) Afin d'empêcher la baisse trop prononcée des prix aux producteurs, les pouvoirs publics subventionnent fréquemment la production intérieure pour accroître les approvisionnements, de préférence à un élargissement des importations. Cependant, ces subventions favorisent certains groupes et n'ont donc qu'une valeur sociale douteuse. (d) Parfois, les pouvoirs publics décident d'intervenir directement vis-à-vis des marchés en créant des offices publics de commercialisation, notamment pour les produits laitiers. L'expérience de ces offices de commercialisation officiels n'a cependant pas été encourageante dans le monde en développement. Cette étude recommande diverses mesures afin de rendre les systèmes de commercialisation plus efficaces et plus compétitifs et d'en augmenter les avantages tant pour les consommateurs que pour les producteurs.

This paper surveys a sample of issues that government planners and policymakers face when confronted with the need to supply growing amounts of meat and dairy products to their domestic markets. In resolving these issues difficult policy choices must be made between import substitution and trade, between farmer income and consumer welfare, between fiscal restraint and government subsidies, and between public intervention and market forces. This paper addressses these policy tradeoffs. It also examines the validity of policy instruments, such as price controls in the context of a market economy, and assesses organizational arrangements for

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marketing of livestock products in the light of the experience accumulated so far in developing countries. Finally, it identifies research priorities that could guide the development of trade, pricing, and marketing policies.

The discussion of trade and marketing issues is preceded by a brief overview of production, consumption, and trade of livestock and livestock products in Asian countries.

- *Production:* The overall increase in livestock population of 5% during the 1970s (of which cattle constituted almost three-fourths) was insufficient to keep pace with the increase in human population, let alone the increase in demand. However, increase in this overall picture masks some spectacular increases such as in Korea where beef and pork production increased 60 and 27%, respectively since 1960 and in Malaysia where the output of the livestock industry more than doubled over the last 20 years, almost entirely as a result of the expansion of the pig and poultry sectors.
- *Consumption:* The per-capita consumption of meat and dairy products remained stagnant or declined over the period 1960–75. However, in Korea beef and pork consumption increased by about 7.7 and 4.2 times, respectively since 1960 and increased to a lesser extent in Malaysia.
- *Trade:* Meat imports remain unimportant overall, but some countries in the region, i.e., Korea, Malaysia, and the Philippines, have started to import significant amounts (46, 16, and 12 000 t, respectively in 1978). On the other hand, Southeast Asian countries have become large importers of milk products; in fact, six countries (Philippines, Indonesia, Thailand, Malaysia, Singapore, and Burma) import about a quarter of the world's trade in milk powder.

Domestic Production vs. Trade

The realization of this increasing dependence on imports to satisfy domestic needs for meat and dairy products is disturbing to most policymakers, and despite the fact that most Asian countries cannot engage in beef or dairy production that would be competitive with the New Zealand or Australian industries, they overwhelmingly choose to cut imports and boost domestic production to satisfy their country's growing needs. This first section assesses the validity of such import substitution policies.

The need to save foreign exchange is often advocated as a major reason to boost domestic production. But although restricting imports is an effective way of dealing with foreign exchange constraints in the short run, the argument is fallacious in the long run if these countries have no comparative advantage in producing dairy and beef, or in other words if they could earn more foreign exchange than they save by diverting the country's resources from livestock or feed production into areas of greater comparative advantage. This is the case for most Asian countries.

A more powerful argument is the desire by most governments to be self-sufficient in strategic commodities. As incomes rise and urban population grows, the demand for these highly income elastic products rises very quickly and there is an understandable tendency to regard livestock products as strategic commodities. In Korea, for example, milk demand is expected to be three times greater in 1990 than in 1975, whereas the demand for rice will only be about 20% greater.

However, in the case of livestock products, self-sufficiency is often illusory. This is the case, if the bulk of feedstuff requirements has to be imported, as in Korea where an estimated 70% of the nutrients required would have to be imported to meet domestic requirements in meat and milk products by 1990; or as in Malaysia where self-sufficiency in pig and poultry now requires more than U.S.$200 million worth of feed imports. Hence, self-reliance is often not a defensible argument either.

The third major reason to increased domestic production of high value beef and dairy products, and the one that has prevailed in many developed countries, is the need to narrow the gap between farm and nonfarm income. One such example is the European Economic Community (EEC), which despite the economic advantages of trade, has protected its livestock industries at the expense of urban consumers. Over the past decade, European consumers have had to pay 1.5 to 5 times the world price for milk powder, and twice the world price for beef. In Asia, the most notable examples of such protective policies are Japan where consumers pay up to five times the world price for beef and Korea where meat and milk prices average two to three times border prices. An increasing number of developing countries (Malaysia, Indonesia, Philippines) have also opted for increased domestic production and reduced trade.

It is important to recognize the social value of such protective policies. In Indonesia, for example, the 20% of the population that lives in urban areas accounts for two-thirds of total private consumption. The outlet for nearly all marketed livestock products is in urban areas where demand rises very quickly. There is a strong case for attempting to satisfy a growing urban demand from a highly protected but not directly subsidized local livestock industry, if this industry is based largely in smallholders, because this policy results in an income transfer from urban to rural areas.

The third Indonesian development plan includes considerable funds for a dairy program along these lines. This strategy has also been pursued in Korea where dairy development is based on small units of two to five animals per household. However, increased domestic production at any cost cannot be justified. Efficiency losses due to domestic milk production are of the order of 50% of the import price in the case of Indonesia and 100% in the case of Korea. Social benefit cost analysis with due regard to alternative sources of farm incomes would allow decision-makers to make an objective assessment of whether the distributional benefits of such protectionist policies sufficiently outweigh the efficiency losses.

Producer vs. Consumer Welfare

A conflicting objective to that of protecting farm production and incomes is the desire to supply consumers with affordable dairy and meat products. In low- and middle-income countries urban consumers are more vocal than rural producers who do not have the same political clout as organized producer groups in developed countries. Aside from this political factor, governments wish to restrain increases in the cost of living to foster development of the manufacturing sector. Another motive is the commitment by many governments to bridge the serious protein gap in the diets of the poor. For these reasons, many governments attempt to regulate prices of meat and milk products while attempting to encourage domestic production.

Price controls are introduced to help urban consumers at the expense of those who are thought to be making excessive profits out of the marketing process. By the same logic, it is wrongly assumed that lower retail prices, while resulting in lower profit for the trade, will not significantly depress producer prices. In reality the unavoidable effect of the long-term control of retail meat and milk prices at unrealistically low levels is that producers will not get the higher prices that would stimulate them to increase their output. Furthermore, very different measures would be needed to effectively reduce marketing margins. These are discussed in a later section.

Price controls will obviously not work unless governments intervene to balance supply with demand at the official price, either by trade policies (increased imports in times of supply shortages, or export bans in times of surpluses) or by providing subsidies to increase domestic production. In the absence of such measures, setting prices at below market clearing levels will cause predictable problems. For instance, if official retail prices for meat and milk are too low in relation to free market prices, there will be excess demand in relation to available supplies. The retailer is likely to react by cutting quality (e.g., adding scraps and bone to meat or water to milk). Eventually only small amounts of meat and milk will be sold in official outlets, while the bulk of those commodities will be available on the parallel market at very high prices, i.e., prices that reflect their actual scarcity plus a risk premium. Moreover, where official prices are controlled, producers will be reluctant to produce. The original purpose of the price regulation is, thus, defeated. Meat is more scarce, consumer prices are higher, and profits are greater.

Fiscal Restraint vs. Government Subsidies

Where a major objective of government policies is to maintain producers' incomes and encourage domestic output, governments will often resort to subsidies to balance out supply with demand at the official price, rather than to trade policies, because imports would depress producer prices. Subsidies may be provided in a variety of ways. In many countries subsidies on feed prices have been used to lower production costs and increase the incentives to raise livestock, thereby increasing supplies in the medium term. Governments can also intervene in the market by procuring at one price and selling below cost. Also, governments can provide income subsidies to increase the effective demand at the supported producer price.

Generally, however, subsidizing inputs have undesirable effects. For example, supplies of the subsidized input may not be sufficient, with the result that the actual input price is higher than was intended. Intervention by government in the marketing of livestock and livestock products suffers from numerous problems that can be traced back to the fact that extreme inefficiency does not ensure the disappearance of a public enterprise. Given the drawbacks of the two approaches mentioned above, income subsidies are generally regarded as more effective and less market distorting.

However, most Asian countries, with the possible exception of oil producers such as Indonesia and Malaysia, cannot afford the luxury of subsidizing the consumption of expensive dairy and meat products, nor is it unequivocally desirable on social grounds. Across the board subsidies of food would be desirable only if these products were largely consumed by the poor, or if the poor constituted a very large proportion of the beneficiary population. Clearly

these two qualifications do not apply to consumption in urban areas of high value items such as milk or meat. In fact, in Asia, milk and meat are not part of the diet of the poor and even at subsidized prices they remain luxury items for lower-income groups.

The correct policy is targeted assistance to the most vulnerable groups, by issuing subsidized rations to them, while passing on the full cost of domestic production and marketing of these products to consumers at large. Because meat is a much less cost-effective source of protein, such targeted schemes should be limited to milk, which is available at low cost on the world market and is likely to benefit primarily children who need protein most. It should be further noted that subsidized milk distribution schemes do not make economic sense to countries that are calorie poor, because milk is a very expensive source of calories. In such cases subsidized foodgrain programs should be given priority. It has been observed that in very poor countries, as for example Sri Lanka, some beneficiaries of cheap milk distribution programs will in fact resell their milk ration to buy traditionally preferred and more calorie-rich food.

Public vs. Private Marketing Enterprise

Governments set up public marketing agencies to run a welfare scheme and to provide services that the private sector does not provide, or seemingly provides at too high a cost. In major producing countries public boards have also been established to provide a degree of income stability for producers faced with highly fluctuating prices. However, this factor is not an important consideration to East Asian countries where livestock is more often a sideline farming activity.

Whatever the objectives of government intervention, the general experience of public marketing agencies in livestock and livestock products throughout the developing world has not been encouraging. Numerous problems have arisen. First, public enterprises that have heavy overhead costs operate on a higher margin than intermediaries in rural areas. Small, labour-intensive private enterprises have competitive advantages in collecting milk or assembling livestock from scattered producers, partly because they benefit from flexibility in operations, close managerial control, and on-the-spot decision-making. Second, livestock and meat marketing calls for professional skills and knowledge of the trade that are not easily acquired by public enterprises. Third, although the size and resources of public agencies lend themselves better to large-scale operations such as wholesale marketing and processing, in practice, they are inefficient because they operate in an environment largely devoid of competition.

The final and most intractable problem is the lack of authority, lack of incentives, and lack of independence of most public enterprise managers. Typically, governments keep a heavy hand on the running of state enterprises, especially with regard to price setting, staff appointments, and salary levels. For instance, the flat price system, which governments often prefer as appearing more equitable to milk producers in all areas, involves national dairy boards in heavy losses on milk purchased and transported from distant areas, besides encouraging uneconomic milk production in unsuitable locations. In Sri Lanka, for example, for some years panterritorial pricing at the farmgate, coupled with a government ceiling on the Dairy Board's selling price made it impossible for the Board to cover its costs. Rapidly increasing annual losses had to be underwritten by a general subsidy. With regard to staffing, the public organization will often be under pressure to provide an exaggerated number of new jobs and to accept senior staff who may be unqualified for their duties. Turnover of senior staff is also high. For instance, the milk scheme in Lahore had five successive managers in its first 3.5 years of operation.

Because of these comparative disadvantages, marketing and processing margins that should have been reduced by public intervention, end up increasing, sometimes dramatically, and shortages appear in the market. The agency's budget falls systematically short of operating costs, and despite huge and rapidly increasing government subsidies, operations remain hopelessly unprofitable, thus destroying any remaining incentive for efficient operations.

Given this unfortunate record, it appears that direct public intervention in the marketing of livestock and livestock products is not an efficient way to provide better marketing services, or even to run a welfare scheme. In the event that governments nevertheless choose for political reasons to set up state marketing agencies, problems can be minimized if the welfare and commercial objectives of the agency are clearly distinguished. Governments should direct state agencies to run the welfare scheme (e.g., supplying milk at low prices to ration shops) as their agent, and should pay them the full cost of the operation. Other operations not classified as welfare ought to be handled along normal commercial lines.

In most cases though, governments should be encouraged to seek alternatives to public sector marketing enterprises to improve the marketing of livestock and its products. If the private sector is unable to provide adequate marketing services, governments

should make it worthwhile for it to do so by providing better infrastructure and an improved policy environment (e.g., price and tax policies). It may also be that under any circumstance it would be uneconomical for the private sector to provide the required services. In such cases, provision of these services should be considered as welfare and dealt with accordingly. If the private sector provides the required marketing services but at too high a cost, governments can take other measures to reduce gross and net margins without intervening directly.

Reconciling Consumer and Producer Interests

Livestock and Meat

The assessment of traders' margins and profits is difficult because prices are not usually related to defined weights and standards of quality, and because livestock traders are apt to be secretive about their operations. Very little systematic work has so far been carried out in Asian countries on this subject. Nevertheless, from the few studies available in Asia and around the world it is clear that planners and policymakers often underestimate the full costs of marketing operations because transport distances and the difficulties of movement as well as the cost and difficulty of holding livestock and storing meat are not sufficiently appreciated. Also, they tend to overestimate net profits because quality and weight losses, risks, and financial charges are insufficiently recognized.

Nevertheless, especially in an outmoded and fragmented marketing system, traders may actually be in a position to take too large a margin for their services, i.e., profits in excess of opportunity costs of the management and capital they put in. This happens when a local trader deals with producers who have insufficient knowledge of market prices and a limited choice of buyers. It may also happen at the wholesale stage of marketing where large-scale operations are possible and a few important traders may control the market and form a ring.

Notwithstanding the lack of detailed knowledge of marketing margins, one can safely recommend measures that would reduce existing margins: either by increasing the efficiency of the system or by placing the farmer in a better bargaining position vis-à-vis the trader. To improve the efficiency of the system, government should provide or stimulate the provision of better infrastructure, such as improved transport facilities to reduce time delays and associated death, weight losses, and deteriorating quality; or such as small market places to cut down assembling costs. The Government of the Philippines for instance has organized 40 country livestock markets in recent years. Keeping in mind that quick turnover is vital to the profitability of trading operations, government should also review existing legislation that may place unnecessary costs and outmoded regulations on the marketing system.

To place the farmer in a better bargaining position vis-à-vis the trader, two conditions should be satisfied: that dealing is largely done on open markets so that current prices are better known, and that there is relatively free entry in the trade. Here again it should be emphasized that public ownership is an inappropriate answer to excessive marketing margins because it limits entry in the trade. Thus to defend producers' interests, the following measures are suggested:

- Establish accurate and timely market information services. Use of the media is an effective way of delivering information on market prices. In most Asian countries, these specialized market facilitating services for livestock and meat are practically nonexistent or have reached only a rudimentary stage;
- Foster competition among traders and, thus, give the farmer different marketing channels. In this respect it is important that legislation that limits entry in the trade be reviewed. Licences to trade livestock and to operate slaughterhouses and zonal restrictions on the transport of livestock have too often been abused and have served to give monopolistic powers to few selected traders. The Thailand market for cattle and pigs is a case in point; and
- Create farmers' cooperatives to improve the bargaining position of small-scale farmers. However, with few exceptions it appears that hardly any livestock and meat marketing cooperatives in Asian countries have succeeded in operating as a fully viable concern either financially or institutionally. Meat marketing is a difficult business. The commodity is highly perishable, difficult to standardize and the market supply situation fluctuates strongly from day to day and from week to week. It has proved difficult to find a sufficient number of qualified managers to operate a marketing system for such a difficult commodity. These constraints on the development of effective farmer cooperatives for livestock and meat in most situations prevent them becoming competitive with established private traders.

Dairy Products

As indicated earlier, the traditional trade in dairy products is efficient and competitive. However, it has shortcomings in terms of hygiene, and more importantly in terms of the scale of operation. Large

modern dairy industries need to be established to supply the needs of rapidly growing urban populations.

In most Latin American countries, milk schemes have successfully been developed under private management. In Africa and Asia, however, private enterprises are not prominent and many major milk schemes are part of the public-sector development programs. In a few cases such as Korea and India, large-scale milk schemes have been successful on a cooperative basis. In Korea milk supplies for Seoul have been rapidly developed through the Seoul Cooperative Milk Scheme, and the Indian Amul system is one of the most widely acclaimed milk cooperatives. In developed countries as well, from Scandinavia to New Zealand, large modern dairy industries have been largely developed on a cooperative basis.

From that record it is clear that cooperation among milk producers in collection, storage, transport, and processing gives special advantages and incentives to efficiency, especially where dairying is based on small-scale farming and provided that good management is assured. The first stage is the formation of simple cooperatives based on collection centres. The ultimate aim is that these village units will coalesce into large cooperative unions capable of acquiring and managing their own plant. Thus, perhaps developing countries should adopt the Scandinavian view that in dairy development the cooperatives are "the only way" to satisfy consumers' needs for large quantities of reasonably priced dairy products while giving producers a fair price.

Research Topics

To guide the development of trade, pricing, and marketing policies for the livestock subsector, attempts should be made to monitor and evaluate the effects of government interventions in the market on production, consumption, and income distribution. The central issues that the research should address are briefly outlined below:

- What are the prevalent kinds and the extent of government intervention?
- What are the theories and goals that underlie the interventions?
- To what extent are actual interventions in harmony with stated objectives?
- In the short- and long-run how do interventions affect producers' incentives and supply responses, resource allocation, employment, income distribution, public savings, trade, and how do they solve the conflict between cheap food for the poor and fair prices for the farmers?

The results of the research would allow policymakers to anticipate the effects of manipulating various policy tools such as administered prices, taxes, subsidies, direct market intervention, etc., thereby providing an objective basis on which to decide the most appropriate set of policies. In the absence of such policy studies, livestock intervention measures will continue to develop haphazardly as a result of various pressures, will have little coherent rationale, and will display internal inconsistencies.

Factors Affecting Production, Processing, and Marketing of Broilers and Hogs in Thailand

Nipon Poapongsakorn[1]

Abstract. This paper identifies the factors that affect the production, processing, and marketing of broilers and hogs in Thailand. The main types of technology used in the broiler and hog industries are investigated to identify the factors that influence the growth in both industries. An appraisal and analysis are also given concerning government policies in the livestock sector and their impact on the broiler and hog industries.

Résumé. Ce document de travail s'intéresse aux facteurs de la production, du traitement et de la mise en marché des poulets à rôtir et des porcs en Thaïlande. Comment identifier ces facteurs ? — par l'étude des principales techniques emloyées dans ces deux industries. On trouveraa ici une analyse et une appréciation des politiques gouvernementales, qui, en intervenant dans le secteur de l'élevage, ont également une influence sur la production du porc et des poulets à rôtir.

Livestock is the second most important subsector in the agriculture sector in Thailand accounting for 13.1% of the agricultural value added. Within the livestock sector, swine and chicken generated 28.4% and 22.3%, respectively, of the livestock value in 1980. Chicken has become more important both in terms of value added and as a source of cheap protein but only after 1973 when Thailand first started exporting a small amount of frozen chicken. Between 1974 and 1981, the production of broilers increased tremendously at an annual average rate of 29.55% (Table 1). At the same time, the swine population has been stagnant. Consequently, the retail price of chicken relative to pork decreased from 0.91 baht/kg in 1960 to 0.72 baht in 1979 (20 baht = U.S.$1.00) (Nipon Poapongsakorn 1981a, p. 3). Moreover, export earnings from frozen chicken have become a significant source of foreign exchange earnings, reaching a level of 650 million baht in 1980 up from only 5 million baht in 1973. Earnings from pig exports, however, only increased from 18.79 million baht in 1970 to 26.25 million baht in 1979.

The main objective of this paper is to identify the factors behind such phenomena and to investigate briefly the structure of production, processing, marketing, and the main types of technology used in the broiler and the hog industries; to identify factors affecting the growth of both industries; and to appraise and analyze some of the government policies that affect the industries.

Broiler Production, Marketing, and Processing

Broiler production is heavily concentrated in the Central Plain. Although official data reveal that the region accounts for 35% of all broilers grown in 1978, experts in the broiler industry estimated that in 1981 three provinces around Bangkok produced 31% of the broilers (Chachoengsao, 13.3%; Nakhon Pathom, 10%; and Chon Buri, 7.8%). Other large chicken-producing provinces are Nakhon Ratchasima and Khon Kaen in the northeast, Chiang Mai and Lamphun in the north, and Songkhla and Nakhon Si Thammarat in the south.

The rapid expansion of broiler production has been made possible by an increase in the number of commercial farms. In 1968, about 3.8% of chicken farmers surveyed in 11 provinces of the Central Region raised chickens as their sole occupation. The figure rose to 48% in a 1979 survey of three provinces in the same region. The average farm size also increased from an average of less than 500 birds/farm to more than 10 000 birds/farm. The largest farms found in Nakhon Pathom and Chachoengsao can raise 600 000–700 000 birds at a time if a system of all-in all-out is practiced. Although most chicken farmers (69% in 1978) still raise a few native chick-

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Table 1. Number of broilers, chickens, and swine, 1970–81 (million units/year).

	Broilers	Chickens I[a]	Chickens II	Swine
1970	—	136.3	58.79	6.86
1971	—	150.7	53.98	5.13
1972	—	166.8	52.78	4.62
1973	—	180.2	61.82	4.46
1974	36.4	190.6	47.81	3.53
1975	41.6	198.5	53.86	4.55
1976	58.2	206.4	49.89	4.04
1977	78.0	211.6	56.31	3.54
1978	104.0	216.9	65.32	4.25
1979	130.0 (180)[b]	222.0	60.54	4.11
1980	176.8 (200)[c]	301.9	na	4.15
1981	(288.0)[c]	na[d]	na	na

[a]Includes broilers, indigenous chickens, and layers.
[b]Data within parentheses derived from "Ruan Prachachart Thurakit" (People's Union Business), 1980.
[c]Data within parentheses derived from interviews with managers of feed mill companies.
[d]Not available.
Source: Data for broilers and chickens I are from the Thai Investment and Securities Co., Ltd. (1979, p. 6 and p. 48, respectively); chickens II, Agricultural Statistics of Thailand, 1979/80 (table 56, p. 79); and swine, Vallentine Laurie and Davies Pty Ltd. (undated, p. 20).

ens (less than 20 birds), almost 70% are now raised in the commercial intensive broiler farms.

There are three important groups of commercial farms: independent farms, price-guaranteed contract farms, and wage contract farms. In 1977, a survey by the Department of Agricultural Economics found that 26% of the farmers in the central Region belonged to the independent category. However, there has been a decline in the number of independent farmers because of severe price fluctuations (with a coefficient of variation of 25%) that have forced especially the small independent growers, into bankruptcy. Some of them have now entered into a price-guaranteed contract with the feed manufacturers or large independent farmers who are also feed dealers in the local areas. This type of contract is becoming very popular, because the farmers do not have to bear the risk of price changes and the contractors do not have to worry about the production, i.e., sequentially reduced, risk.

The wage contract, first introduced by the Charoen Phokphand Company (CP), the largest feed manufacturer in Thailand, is more popular among farmers who have no previous marketing experience. Not many feed companies want to enter into such a contract because of the high enforcement costs. In 1980–81, CP and its contracted farmers produced an estimated 26–30% of the total number of broilers raised in Thailand, whereas the nine largest feed manufacturers shared about 60–65%. These feed manufacturers also controlled up to 80% of the markets for day-old chicks and animal feed (Table 2).

There are two important groups of live chicken wholesalers: the wholesalers in the Bangkok central market who used to control most of the market share 10 years ago but now share only 10–15% of the market (most of these wholesalers are Chinese and Muslims who only buy chicken, slaughter them, and sell the dressed chicken); and six feed manufacturers who also own modern chicken slaughterhouses and control almost 75–80% of the market. The rest of the market share is in the hands of small wholesalers. Moreover, a few feed manufacturers, who own chicken farms and have contracts with chicken-farmers but do not own slaughterhouses, also sell their chickens to the above two groups of wholesalers. Table 2 also indicates that the three feed manufacturers and Saha Farm, which does not have a feed mill, control 100% of the export market. Saha Farm and CP each share more than one-third of the market. Most of Thailand's export (95%) goes to Japan (Table 3).

Retailing of dressed chicken and chicken parts is in the hands of many small retailers in the consumer markets. A large market in a populated community may have as many as 10–15 retailers, whereas a smaller market has only 3–6 retailing stalls. In Bangkok, there are about 220 consumer markets.

Whenever possible, broilers are loaded for transport at night because at night they are easier to catch and the risk of death and drastic weight loss can be reduced when broilers are shipped during the cool nighttime. A six-wheel truck is a popular means of transport. Each truck can carry between 1500 and 1700 broilers.

Table 2. A summary of market and production concentration.

Activities and firms	Year	% of share
Day-old chick hatchery		
Charoen Phokphand Company (CP) and its members	1981	40–45
CP, Laemthong, Centago, Betagro, Thai Feed Mill Industry, Sri Thai, and P. Charoenphan	1981	80
Animal feeds		
CP and its subsidiary	1980	33–40
CP, Laemthong, Centago, Betagro, Krung Thai, Sri Thai, Laemthong Kaset, Inter Industry Trade	1980	70–80
Drugs, vitamins, and premix CP (Advance Pharma), May and Boaker, Dietham, Welknow, Pfizer, Thai Pharmi, etc.	—	na[a]
Broiler farms		
CP and its contracted farmers	1980–81	26–30
Including contracted farmers: CP, Betagro, Centago, Sri Thai, Laemthong, First Farm, P. Charoenphan, Krung Thai, and Saha Farm	1980–81	60–65
Chicken trading in Bangkok (live and slaughtered)		
CP	1981	40–45
CP, Saha Farm, Centago, Betagro, Sri Thai, and Laemthong	1981	70–80
Export		
CP (Bangkok livestock trading)	1980	38.9
Saha Farm	1980	32.4
Laemthong	1980	19.5
Centago	1980	9.2
Retailing		
Almost 3000 retailers in 220 markets in Bangkok	—	na

[a]Not available.

Source: Data for day-old chicks are derived from Nipon Poapongsakorn (1982, pp. 11–12); animal feeds, Nipon Poapongsakorn et al. (undated); drugs, vitamins, and premix, Nipon Poapongsakorn (1982, table 2.7); broiler farm, Nipon Poapongsakorn (1982, table 2.8); chicken trading, Nipon Poapongsakorn (1981a, p. 57); and export, Nipon Poapongsakorn (1982, pp. 24–25).

Chicken enters the processing chain through three main avenues: backyard slaughter at the point of sale such as restaurant and consumer markets, traditional slaughter by wholesalers in the chicken central markets in Bangkok, and registered export slaughterhouses operated by six feed companies. The technique used by the first two groups is labour-intensive where almost all stages of operation are done manually. Only 10–25 hired and family workers are needed to slaughter 1000–3000 birds a night. The export slaughterhouses are very capital-intensive and productivity is high. Some plants are capable of slaughtering up to 75 000 birds in 8 hours. The rate of capacity use varies from almost 100% for the leading firms, such as CP, to 28% for the new slaughterhouses. Working hours are between 23:00 and 03:00 hours, because dressed chicken must be delivered to the consumer markets early in the morning. Thus, no cold storage is needed in the transport system, except for the shipment of frozen chicken for export.

Factors Affecting Growth of the Broiler Industry

The rapid expansion of the broiler industry in less than a decade (1973–81), which made Thailand the eleventh largest broiler-producing country in the world (by comparing broiler production in Thailand with figures from various countries compiled by "Poultry International," January 1981), is characterized by the emergence and dominance of a few large, vertically integrated firms. Four major factors that have contributed to an increase in the production of low-cost poultry are nutrition, genetics, disease prevention, and technology and management. Knowledge of these factors must be obtained from foreign multinational companies. Hence, investment in the industry is very high, and the broiler industry is dominated by a few oligopolistic firms.

New technology has helped to cut production costs drastically by improving the feed conversion ratio from 2.55 in 1972 to 2.00 in 1976 and reducing the growth span from 75 to 56 days. To reap high profits and exploit economies of scale, the pen size must be large enough to accommodate at least 5000–10 000 birds/pen. A pen with 10 000 birds requires one full-time worker and six trucks to load the birds. The large-scale producers who buy feed in large lots are usually given 1–3 month's credit and can afford veterinary and animal husbandry services. Modern processing technology enables the large-scale producers to process more chicken in a shorter time, whereas a drum-shaped defeathering machine used by small wholesalers can process only 200 birds/hour, but the modern rubber-fingered feather picker can defeather 2800–9000 birds/hour, depending upon the scale used.

As a result of advances in technology, there has been an integration of production, processing, and marketing within the poultry industry. Because feed is the largest single cost of production, it is only natural that feed companies sell their feed to producers on a loan basis. To protect their investment, and to ensure healthy, day-old chicks and a stable market for broilers, hatcheries and processing plants as well

Table 3. Export of frozen chicken.[a]

Year	Quantity	% to Japan	% to others[b]	% change in quantity	Value (1000 baht)	% change in value
1973	142.2[c]	na[c]	na	—	5530.0	—
1974	446.8[c]	na	na	214.2	14600.0	164.0
1975	372.5	98.39	1.61	−16.6	8932.5	−38.8
1976	2210.8	99.81	0.19	493.5	65305.7	631.1
1977	4254.5	99.56	0.44	92.4	157514.8	141.2
1978[d]	9286.5	99.74	0.26	118.3	333735.5	111.9
1979	14158.2	99.99	0.01	52.5	516954.6	54.9
1980	18503.1	94.20	5.8	30.7	656192.4	26.9
1981	24000.0	na	na	29.7	na	—
Growth rate	—	—	—	64.1	—	68.2

[a]Data code from the Department of Customs refers to fowls and ducks, fresh, chilled, and frozen (includes a very small amount of duck).
[b]Other countries include Hong Kong, Laos, France, Malaysia, Sri Lanka, and Romania. In 1981, Austria, Saudi Arabia, and Kuwait became new importers.
[c]In 1973 and 1974, according to data from the Department of Customs, 137.78 and 337.41 t were exported, respectively. The corresponding figures for export value were 5.53 and 14.35 million baht, respectively.
[d]In 1978 and 1979, Thailand also exported 3113 and 1031 baht, respectively, worth of live chickens (day-old chicks) to Indonesia.
[e]Not available.
Source: Data for 1973–74 are derived from the Bangkok Livestock Trading Co., and data for 1975–80 are from the Department of Customs, foreign trade statistics.

as breeding farms have become involved in integrated operations. Moreover, to ensure a regular supply of chickens for their large processing plants, feed companies also contract with small and large chicken farmers. Vertical integration results in lower production and marketing costs. For example, a laying hatchery in a vertically integrated firm will be able to measure the performance of various flocks of parent stock at the company's breeder farm. Transport costs of day-old chicks and feed to the contract farmers can be cut down by using returnable plastic chick containers and a silo-type truck that can deliver feed in bulk instead of in paper bags. The integrated firm can also determine the arrival time of trucks carrying broilers at the slaughterhouse so that the mortality rate and weight loss are minimized.

Financial factors also work in favour of the large chicken farmers as well as the large processors. Because feed and broiler prices fluctuate, a decrease in the price of broilers relative to feed costs can considerably affect the financial status of the small-scale chicken producer. Large-scale producers are also affected by such price changes but are in a better position to handle the problem.

The export of frozen chicken is another factor that helps to encourage the growth of the broiler industry. Although chicken exports account for only 7.6% of the total production, large profit margins encourage feed manufacturers to expand their business. Although only 3.00 baht of gross profit (or 0.50 baht of net profit) can be earned by selling 1 kg of New York Dressed (NYD) chicken in the local market, as much as 10 baht of gross profit (or 5.00 baht of net profit) can be earned from export.

Exports have grown rapidly at an average annual growth rate of 64% during 1973–81 (Table 3) because of Thailand's comparative advantage in labour costs. Although the cost in Japan of one frozen NYD chicken from Thailand is 20–30% higher than from the U.S., the labour cost is much cheaper (the daily minimum wage, set by law, in 1981 is 61 baht compared with about U.S.$4/hour in the U.S.). Therefore, the price of cut-up parts from Thailand relative to the price of NYD from the U.S. is cheaper from the Japanese view point. Transport costs from Thailand are also cheaper because of the shorter distance. (Freight charges for 1 t of frozen chicken sent from Thailand to Japan in cold storage are U.S.$131.50 and U.S.$140.00 if shipped in a container.) The higher price of uncut chicken can be attributed to the high costs of raw materials used in producing feeds, especially soybean cake, and the low quality of corn and the inexperience and ignorance of chicken farmers. Because most of the Thai agricultural products are produced by small-scale farmers and secured by small-scale traders, and because the prices they receive are usually low due to heavy agricultural taxation and export quotas, quality is always a problem in expanding exports.

Thailand's abundance of feed grains and fish meal is also another factor stimulating the growth of the broiler industry. Thailand is among the countries in Asia that can export corn, cassava, fish meal, and even ready-mixed animal feeds. A number of factors have restricted the growth of the industry. High temperature and humidity during the summer months of

March and April create stress that makes broilers less resistant to disease. Other factors include a lack of mortality records among chicken farmers, inexperienced growers, and failure to properly disinfect the pens or leaving them vacant for more than a week. These factors contribute to a 5–10% condemnation rate at the modern slaughterhouse.

Another important constraint is that live chickens must be brought to the slaughterhouses in Bangkok because it is the largest consumption market as well as the main export point. The average distance is about 100 km and it cannot exceed 150 km. The mortality rate during night transport is already high at 1–3%, compared with 0.3% in the U.S. This disadvantage may be offset by access to public utilities, particularly water, because 20 L of water is required to process 1 kg of chicken.

Government regulations on poultry marketing and slaughtering are minimal compared with those in the hog industry. The export tax is small so that chicken parts from Thailand are highly competitive in the Japanese market. The almost complete absence of government regulations is perhaps the major reason why private firms have a strong incentive to expand their business. The investment privileges granted to the modern slaughterhouses that process chicken for export as well as to feed mills appear to foster a rapid expansion in chicken exports. They tend to increase by stimulating more chicken raising without lowering the prices received by the chicken farmer.

Low-interest loans have not yet been a major factor because poultry loans accounted for only 1.3% of the Bank of Thailand's short-term loans available for agricultural activities. Although the Bank of Thailand's rediscount facilities have not been extensively used by animal raisers (the total value of bills of exchange from all kinds of animal raising rediscounted by the Bank was 184.34, 233.60, and 236.94 million baht in 1977, 1978, and 1979, respectively), many contract growers in the CP contract project had obtained the facilities through the Thai Farmers Bank. One disincentive may be the method of computing tax on income. Proprietors or self-employed farmers have to pay tax on the basis of personal income tax, i.e., they are allowed to deduct 75–85% in standard deductions and certain exemptions from their annual income during the tax year. This means that they must always pay tax once their gross income exceeds 20 000 baht, even though they may have suffered a heavy loss in that year. Losses in previous years cannot offset profits as in the case of corporation income tax computation. The high standard deductions have encouraged them not to keep expense accounts because keeping accounts may result in paying higher taxes. The result is that they try to evade tax by underreporting income.

Hog Production, Marketing, and Slaughtering

Although the data on hog production are not reliable, the agricultural censuses by the National Statistical Office in 1963 and 1978 showed that swine production increased by only 62% or by an annual growth rate of 4%. The Central Plain accounted for about 36–40% of the total number of swine. The northern region was the third largest production area in 1963, but it has now become the second, producing about 26–30%, whereas the northeast and the south account for 23–25% and 13–14%, respectively. The major hog-producing provinces are also the largest chicken-producing areas. Backyard hog production, run as a sideline by the small-scale rice farmers, still accounted for 83% of total production. Only 0.18% of hog producers raised more than 100 swine/farm. Medium- and large-scale commercial farms only developed slowly with the encouragement of a few feed mill companies and government provision of cheap cross-bred piglets and boar loan services. Contract farming for hog fattening and piglet production is still extremely limited.

Because most swine are raised by small farmers, the small local intermediaries still play the important role of assembling pigs in various villages. Pig farmers can sell their hogs to different intermediaries who are local assemblers or commissioned agents of other hog wholesalers. These hog wholesalers sell to the carcass wholesalers at the slaughterhouse or to the large wholesalers, who in turn may ship the hogs to the carcass wholesalers in Bangkok, because Bangkok is the largest pork consumption area. They are the most powerful group of wholesalers in the hog market because of the law requiring that pork carcasses must be slaughtered and sold in the same area. Because the law also prohibits private individuals from establishing private slaughterhouses unless all the property rights are transferred to the local government, the number of slaughterhouses is usually limited to one per locality,[2] regardless of the total number of pigs produced. Because many carcass wholesalers are also slaughterhouse owners or have developed a special relationship with local officers who issue slaughtering permits, they enjoy both monopolistic and monopsonistic power. (Some carcass wholesalers even resort to using violent measures to threaten potential entrants.) Retailing of pork is carried out by thousands of small-scale retailers. Each market has about 5–10 retailers. It is estimated that there may be as many as 2900 retailers in Bangkok.

[2]In Thailand, there are about 350 slaughterhouses; about 100 are municipal slaughterhouses. In Bangkok, there are five small slaughterhouses and one modern abattoir.

Hogs are also caught and shipped at night for the same reasons given for night transport of chickens; however, they are usually transported several hundred kilometers to the slaughterhouses. A 10-wheel truck, which can load up to 80–100 live pigs, is a common means of hauling live pigs as well as pig carcasses. There are three types of pig slaughterhouses in Thailand: (a) two modern abattoirs with well-equipped slaughtering facilities, (one belongs to the Bangkok Municipal Authority (BMA) and the other to the Ministry of Defense); (b) about 100 municipal slaughterhouses found in the main districts (called *amphoe*), which are equipped with holding pans and killing floors and some have separate rooms for storing carcasses; and (c) about 250 simple slaughterhouses, which have small killing floors to perform all kinds of slaughtering activities. The average numbers of hogs killed at the BMA, municipal, and simple slaughterhouses are about 1000, 73.5, and less than 10 pigs/day, respectively. All the slaughterhouses use a traditional and cruel method of slaughtering. The modern facility at the BMA plant (worth 50 million baht in 1979) has never been used, because the carcass wholesalers will not be able to evade income tax if pigs are mechanically slaughtered, a process that automatically records the number of hogs killed.

Constraints in the Swine Industry and the Effects of Government Policies

The most crucial factor that hinders the growth of the pig industry is the impact of the various government policies and intervention in the industry (Nipon Poapongsakorn 1981b, pp. 132–155). The Animal Slaughtering and Meat Sale Act is the major constraint in the development of the swine industry. The law requires that all the slaughterhouses must be established and managed by local authorities or municipalities. Private individuals are able to establish slaughterhouses only if they transfer property rights to the local governments. Furthermore, carcasses cannot be shipped outside the legal market area of each slaughterhouse, except with special permission from the Director General of the Department of Local Administration.

The ostensible purposes of these regulations are to provide a regular source of income for the local government (as well as for the local officials who control the slaughterhouses); to control illegal slaughter and to ensure that sanitary slaughtering conditions are maintained (the law is reinforced by a system of licencing livestock movement, meat inspection, and slaughtering permits); and to prevent a monopoly.

Another important factor mentioned earlier that seriously affects the industry is the method of collecting and calculating income tax from hog and carcass wholesalers. Besides the problem of standard deductions mentioned in the case of chicken, hog as well as pig carcass wholesalers pay income tax on every pig sold and slaughtered. Tax must be paid immediately at the point of sale and slaughter. The purpose of the law is to prevent tax evasion, because it is difficult to assess the annual revenue of these wholesalers. However, the aims of these regulations are never achieved and indeed, in many cases, the effect is totally opposite to the original intent.

First, slaughterhouse standards are so low that the slaughterhouses have probably spread disease. The operators have no direct interest in maintaining satisfactory standards because they have no property rights. With no improvement or investment the results are poor sanitary conditions, overall deterioration in slaughtering methods and procedures, waste, and pollution, etc. Second, the charges and income tax levied on every pig traded or slaughtered — even if losses are incurred — are so high that they promote illegal slaughter in the government slaughterhouses. (Taxes and charges total 48–58 baht per slaughtered pig, or about 2% of the selling price. Therefore, if a carcass wholesaler sells 40 carcasses a day, the wholesaler would have to pay 1920 baht in taxes.) This explains why 50–60% of pigs are slaughtered illegally.

Third, because meat inspection is under the control of the Department of Local Administration instead of the Department of Livestock Development as in the case of chicken processing, meat inspectors are not qualified and can be intimidated or bribed to pass suspect organs or carcasses. As a result, most meat sold to the consumers has not been inspected to detect disease and has been prepared under unhygienic conditions.

Fourth, the law prohibits shipping carcasses across different slaughterhouse trading areas; therefore, live pigs are usually hauled a long way to the market, and, because no premium price is paid, they are not handled with care during transport. Although they are usually shipped at night, they are sometimes transported several hundred kilometers without water or feed in overcrowded conditions in the 10-wheel trucks. (One truck can carry 100 hogs by putting each one in a bamboo coop, and sometimes it can take more than 10 hours to reach a slaughterhouse.) The pigs arrive dehydrated, bruised, or more seriously injured and stressed. If the law were changed, it would be more economical to transport carcasses than live animals because eviscerated carcasses and offal transport allow for a higher loading capacity and results in little loss due to bruising, etc. More-

over, the transport of live animals involves loading and unloading facilities, holding yards, fodder, contributes to in-transit stress (ketosis is very common) and bruising, and results in a lower-quality meat. The present system unnecessarily increases marketing costs and leads to lower income for pig farmers and wholesalers

Fifth, the industry cannot export fresh, chilled, and frozen pork because of the unhygienic conditions in the slaughtering plants and illegal slaughter. A recent Cabinet decision permitting private firms to establish slaughterhouses for export will not change the structure of the industry. The requirement of a minimum capital investment of 100 million baht will encourage a monopolistic situation.

In each administrative or trading area, only one private operator, and, hence, one slaughterhouse, is permitted. This decision enables local government officers to maximize their benefits. To influence the market prices, which are still largely determined by demand and supply, local officials try to maximize their profit subject to buying hogs at the market price. First, they use surreptitious methods to discount the animals by delaying supply trucks for several hours in front of the slaughterhouse, using inaccurate weight scales, and by claiming that animals are injured after keeping them in a coop for a long time.

During 1959–62 and 1978–79, all slaughter permits were given to a group of carcass wholesalers and pig farmers who formed a pig cooperative. The pork wholesale trade in Bangkok was monopolized. Pig raisers were not paid or were paid lower prices. The first cooperative was dissolved by the government because its manager had a serious business conflict with the prime minister, whereas the second cooperative went into bankruptcy. There were also several other government interventions between those two periods (see Nipon Poapongsakorn 1981b, pp. 41–59). The net effect was that the market was always being disrupted with uncertain and changing policies. Uncertainties in the government policies and measures partly account for the wild cyclical swings as well as the stagnation in production (Nipon Poapongsakorn 1981b, pp. 112–158).

Conclusions

This study has demonstrated that the rapid growth of the broiler industry can be explained by technological and structural factors as well as the absence of government intervention. Modern technology in nutrition, disease control, breeds and farm management have significantly contributed to lower production costs. Thailand's abundant feed grains and fish meal have also indirectly contributed to growth. To successfully capture the benefits, the feed manufacturers have to combine various vertical stages of production. Vertical integration is necessary to ensure a regular supply of chicken at stable prices. By reducing the marketing costs, farmers can increase their share of benefits. Consumers and society as a whole benefit with only temporary gluts in supply and high transport costs resulting from the location of slaughterhouses and farms around Bangkok.

Traditional low-input backyard producers continue to dominate the swine industry. Although technology is available, intensive commercial farms are still limited. Foot-and-mouth disease (FMD), hog cholera, pneumonia, and viral influenza still plague the country. Slaughterhouses are unhygienic, substandard, and spread disease. Illegal slaughter is universal and meat inspection is rare. Both the wholesale and retail trades are in the hands of many small traders. Although the market can be characterized as competitive, the carcass wholesalers and slaughterhouses are granted local monopolistic powers. Government intervention and lack of understanding of the role of market forces have created most of the above problems.

Policy Recommendations for the Broiler Industry

- A crisis situation in the chicken industry is usually only of a temporary nature. However, there is evidence that the large feed mill firms have attempted to form a collusive agreement. Fortunately, such action often fails due to counter action by some independent producers. Although future chicken production does not require any government assistance, an information centre is needed to collect and disseminate information to all the parties in the industry. Government may not be able to handle the task because the centre must function very effectively to collect and update information weekly.
- The method of high standard tax deductions for self-employed taxpayers (including chicken raisers), which encourages them not to use actual expense accounts, should be gradually phased out (see Krongkaew 1981, p. 17).
- Various measures should be devised to improve the productivity of the feed-grain farmers. For instance, research on appropriate high-yield varieties should be supported on a larger scale. Existing government export taxes and quotas that depress the farmgate prices should be phased out.
- The government should actively negotiate with foreign governments to diversify markets.
- Backyard production should be encouraged as

another source of meat protein for the majority of the rural poor. Foreign aid as well as tax proceeds from the industry should be harnessed to help develop local technology and local breeds suitable for production of both meat and eggs.

- Investment promotional privileges still in effect should be used to redirect the location of the growing and processing industry into up-country areas where animal feeds are abundant. Such policies will help reduce transport costs and improve income distribution.

Policy Recommendations for the Hog Industry

The following recommendations are a brief outline of a more detailed series of suggestions from Nipon Poapongsakorn and Rungsun Thanapornpun (1981):

- The Animal Slaughtering and Meat Sale Control Act should be revoked. Private establishment and ownership of slaughterhouses should be allowed. The carcass and meat trade should also be liberalized. Such changes are crucial to break the stagnation of the industry.
- Permission to establish a slaughterhouse should be granted by the Department of Factories. A new strict system of animal and meat inspection by veterinarians from the Department of Livestock Development is needed.
- The existing practice of income tax collection from hog shippers and carcass wholesalers must be reformed to reduce tax evasion. The same system of income tax should be applied to both chicken and hog producers.
- Government should launch effective programs to wipe out or control swine diseases. No animal should be allowed into a disease-free zone until other areas are also free of disease.
- There should be no quotas on hog exports, but their inspection should be strictly enforced as in the case of chickens.
- Small-scale producers should be encouraged to grow weaners, which is a care-intensive activity. However, a package of measures including credit, breeding, nutrition, farm management, and marketing is required.
- Because reasonable export potential for processed meats like ham and bacon, already exists, technical assistance in slaughtering and meat processing is required to help overcome the poor reputation that Thai food products have in potential overseas markets. However, if the law is not changed there will be no incentive for private entrepreneurs to invest under the present system of marketing and slaughtering.

In summary, the most important policies that the government should rapidly adopt are (a) to provide information on prices, production, and the market situation to animal raisers and traders, especially in the chicken industry, and (b) to immediately abandon the Animal Slaughtering and Meat Sale Control Act and to liberalize the slaughtering and marketing activities.

International Markets for Livestock and Livestock Feed: Their Role in Livestock Development in Asia

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Abstract: The objective of this paper is to provide an international perspective to livestock sector policy planning in Asia. It first examines selected commercial implications of world markets for livestock products and feedstuffs, especially for importing countries in Asia. The international markets for these products are characterized by expansion, significant year-to-year price fluctuations, and major policy distortions, all typical of world agricultural markets. Importing as well as exporting countries can benefit considerably from improved market monitoring and research from a national perspective.

International markets also need to be considered from a policy perspective. With adjustments, world prices can serve as a useful reference point for domestic production, consumption, and price policies. It will not normally be desirable to accept unadjusted border prices as domestic prices, because this policy often leads to unacceptably high price variability. In such situations, risk averse policymakers will choose to set domestic prices somewhat higher than the world price for stability reasons and to give appropriate incentives to domestic producers.

Résumé. L'objectif de ce document est de fournir une perspective internationale aux planificateurs asiatiques du secteur du bétail. L'examen porte d'abord sur certaines implications commerciales des marchés mondiaux pour les produits du bétail et les provendes, spécialement en ce qui concerne certains pays d'Asie importateurs. Les marchés internationaux pour ces produits sont caractérisés par l'expansion, des fluctuations importantes de prix d'année en année et de graves distorsions en politique marchande, tous traits typiques des marchés agricoles mondiaux. Les pays importateurs aussi bien qu'exportateurs pourraient bénéficier considérablement d'une meilleure recherche et d'un meilleur contrôle du marché, dans la perspective nationale.

Les marchés internationaux doivent être considérés sous une perspective politique. Après ajustement, les prix mondiaux peuvent servir de référence utile en production, consommation et politique des prix nationales. Il ne serait pas normalement désirable d'accepter comme prix nationaux les prix internationaux non ajustés parce que cette pratique conduit souvent à des variations trop élevées. Dans des situations de ce genre, les administrateurs ennemis du risque choisiront d'établir les prix nationaux à un niveau un peu plus élevé que le prix mondial pour des raisons de stabilité et pour donner des encouragements appropriés aux producteurs nationaux.

Livestock development in Asia can be seen from the perspectives of four broad groups of decision-makers. First, there are the livestock producers who, in conjunction with researchers, input suppliers, and extension officers, are responsible for the development and implementation of appropriate livestock systems and the generation of output. Second, there are the marketing agents, who may be the farmers themselves acting in cooperatives and who are responsible for performing a wide range of functions associated with assembling animals and products for processing, distribution, and final sale. Consumers are the most important group who demand livestock products and who judge their standard of living, to some extent, by their ability to consume higher valued food products.

The final set of economic actors is that amorphous group that we call policymakers; amorphous because the group includes a wide range of analysts, researchers, and industry representatives from government, universities, and private groups and institutions in addition to officials and Ministers. Their task consists of developing and setting a range of policy instruments to ensure that the performance of the livestock sector is at a desirable level. This diverse set of policies ranges from research and development

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and extension services to marketing, pricing, and trade policy. To a considerable degree, this set of policies will define the limits of feasible and profitable action by the other three groups of decision-makers.

International markets for livestock products and feedstuffs have a role to play by providing a potentially profitable outlet for products that are surplus to domestic requirements. More important, the international market is a source of product to balance domestic supplies with demand in deficit situations, particularly in the Asian context. This is the commercial role of world markets in livestock development strategies, but there is another. The world market prices of the various livestock products and feedstuffs, at the border, indicate in a general way the opportunity cost of the product. They are the most commonly used benchmarks against which one can measure the efficiency of alternate proposals.

Table 1. World production, consumption and trade in selected commodities, 1979 (10^6 t).

	Beef	Coarse grains	Oilseeds
Total production	47.3	724	51.9
	(29.6)[a]	(431)	(27.2)
Growth in production (%)			
1961–77	2.9	3.0	3.7
1977–80	0.2	3.7	3.3
Total consumption	46.9	740	51.8
	(—)	(418)	(27.3)
Growth in consumption (%)			
1961–77	—	2.9	3.6
1977–80	2.4	4.7	3.6
Total exports	3.16	96	16.1
	(1.08)	(26)	(7.8)
Growth in exports (%)			
1961–77	4.8	7.2	4.1
1977–80	1.8	1.1	4.5

[a]Figures within parentheses are for 1961.
Source: Foreign Agriculture Circular, USDA and Trade Yearbook and Production Yearbook, FAO, various issues.

Commercial Aspect of International Markets

Livestock product and feedstuffs markets have long performed a valuable role in enabling countries to rationalize agricultural resource use at the margin. With the exception of a few countries including Singapore, import supply does not usually constitute a large proportion of total domestic supplies. As a result, international trade in these products has represented between 5 and 15% of world consumption (trade tending toward the lower bound for livestock products and toward the upper bound for cereals and feeds). This is illustrated in Tables 1 and 2. Notice that trade as a percentage of production in oilseeds approaches one-third at the present time. This is not true on the export side, exports often constituting a large proportion of domestic production in trading countries. Furthermore, the export markets for these commodities are concentrated within a few countries, and the degree of concentration is increasing. An excellent review of the structure of some of these markets is provided in McCalla and Josling (1981). These markets are characterized by few sellers and few buyers. As a result significant premiums for market information exist. This has implications for market intelligence and research work in trading countries.

These structural considerations have given rise over the years to a debate, still unsettled, as to the appropriate theoretical framework within which to view the world cereals market. Furthermore, the polar positions in the debate may be even more valid in international meat and dairy product markets. On the one hand is the argument formalized by McCalla

Table 2. World production, consumption, and trade in red meats, 1981 (10^6 t).[a]

	Beef	Pork	Sheep and goat	Total red meat
Production	40.54	36.94	4.47	80.68
	(39.82)[b]	(31.56)	(4.57)	(74.88)
Consumption	39.74	36.87	4.25	70.59
	(39.33)	(31.58)	(4.55)	(74.40)
Exports	4.08	2.56	0.93	7.57
	(3.68)	(1.97)	(0.77)	(6.43)
Imports	3.32	2.43	0.69	6.44
	(3.12)	(1.99)	(0.72)	(5.83)

[a]The world consists of selected countries that make up all major producing and trading countries.
[b]Figures within parentheses are the 1973/77 average.
Source: Foreign Agriculture Circular, USDA, FLM-781, 1981.

(1966) and Alaouze et al. (1978) who argued that world cereal markets tend to be oligopolistic with the major exporters implicitly extracting a rent from importers through supply and pricing behaviour. This theory has a certain popular appeal and is often used as an argument for import substitution on the one hand and the potential for cartels on the other.

At the other end of the spectrum lies the argument that major importers have in effect applied optimum tariffs in world cereals markets and that these markets tend to be oligoposonistic (Carter and Schmitz 1979). The forces and instruments that could potentially give rise to both frameworks certainly exist in the market place for most livestock products and feedstuffs. By definition, the small participant is unable to influence the market, but the elements do imply that a small country can make gains from improved market information and contingency planning. It does not imply that importers should necessarily minimize dependance on these markets but rather use them intelligently.

The various types of intervention referred to earlier give rise to major distortions in these world markets. Aside from tariff and nontariff barriers and explicit export subsidies, the most prevalent types of intervention are production subsidies, price supports, and implicit consumer taxes. Furthermore, importers do not have a monopoly on such measures, although their incidence tends to be somewhat less in exporting countries. One can gain some appreciation of the size of the distortions involved by examining the domestic price data in Tables 3 and 4. For example, of the 50 major coarse grain-producing countries surveyed in Table 1, 32 countries have domestic prices at least 50% above the representative export price (at least U.S.$125/t in 1978 compared with the representative export price of U.S.$83). A similar situation exists for wheat. The level of distortion in world dairy product markets is considerably more distorted, as is well known.

The implications of this situation are basically two-fold. First, the so-called world price for these commodities is lower by a large margin and tends toward the domestic price of the least-cost supplier; the country with the strongest comparative advantage in the commodity. Hence, from a commercial perspective, the product is very cheap. Second, the world market price tends to be more unstable than otherwise, because the prevalent instruments used make export supply and import demand schedules more inelastic (Zwart 1977). These points are important from a strictly commercial standpoint and also from a policy evaluation perspective, as will be shown in the next section.

Table 3. Distribution of domestic prices, selected commodities, and countries (1978, U.S.$/t).

Price level	Wheat	Corn	Milk[a]
Low	<100 (1)[b]	<75 (1)	<150 (5)
Medium	100–150 (15)	75–125 (17)	150–250 (16)
High	150–200 (16)	125–175 (13)	250–350 (10)
Very high	>200 (17)	>175 (19)	>350 (2)
Representative export price	112	83	100

[a]Milk prices are expressed in terms of milk equivalent.
[b]Figures with parentheses are the number of countries.
Source: Foreign Agriculture Circular, USDA, FG-6-79, 1979, and Lattimore and Weedle (1981).

Table 4. Producer prices of animal products in selected countries (average for 1977–79, U.S.$/100 kg).

	Slaughter weight					
	Cattle	Pigs	Lamb	Chickens	Milk	Eggs
Argentina	109	105	—	—	—	—
Australia	100	137	102	—	11	117
European Economic Community	297	169	420[a], 318[b]	135[c]	26[d]	137[c]
Japan	582	270	—	130	51	109
Republic of Korea	569	273	—	191	36	125
New Zealand	78	127	76	—	8	101
Sweden	335	179	326[e]	198	34	110
Switzerland	515	272	580	290	38	201
United States	199	118	190	80	22	79

[a]France.
[b]United Kingdom.
[c]Germany, F.R. only.
[d]Target price.
[e]Average mutton and lamb.
Source: FAO, "Protectionism in the livestock sector," CCP ME80/4, October 1980, table 3.

Tables 5, 6, and 7 trace the movement in representative world prices of beef, pork, corn, and soymeal in real and nominal terms over the period 1950–80. The first point to be kept in mind is that these are annual average prices and, hence, exhibit smaller fluctuations than weekly or monthly data. All these series show marked fluctuations in both real and nominal dollars. This pattern is to be expected given the wide array of market forces impinging on these markets and the policy setting restricting these markets.

The trends in these prices in real terms are revealing. Beef prices have tended to maintain their real value in contrast to feedstuffs. This reflects the slow rate of technological progress in the industry over the past 30 years and substitutes in production in the face of increasing import demand. Up until the 1970s, pork prices were relatively stable and appear to have stabilized since 1975 following the adjustment in grain prices to a higher nominal plateau. Animal feeds on the world market are represented here by corn and soymeal. Real corn prices have declined more markedly over the period than for soymeal, although both have exhibited this tendency.

From the point of view of the individual country, however, world prices have to be evaluated in do-

Table 5. International meat prices.

Year	United States[a] Pork (U.S. $/cwt)		Argentina[b] Beef (U.S.$/kg)		Australia[c] Beef (U.S. $/kg)	
	Current $	1970 constant $	Current $	1980 constant $	Current $	1980 constant $
1950	18.39	25.54	—	—	—	—
1951	20.74	24.40	—	—	—	—
1952	18.28	21.01	—	—	—	—
1953	22.03	26.54	—	—	—	—
1954	22.13	26.99	46.2	195.8	35.2	149.2
1955	15.16	18.49	46.1	192.1	31.6	131.7
1956	14.69	17.28	40.1	163.0	30.2	122.8
1957	18.28	21.01	43.0	167.3	32.8	127.6
1958	20.28	23.05	42.8	157.9	38.5	142.1
1959	14.84	16.87	44.1	170.9	47.7	184.9
1960	16.05	17.83	42.6	161.4	50.6	191.7
1961	17.26	19.18	41.6	157.0	43.8	165.3
1962	17.09	18.99	33.3	127.1	38.6	147.3
1963	15.74	17.49	35.7	135.2	43.2	163.6
1964	15.65	17.01	57.0	212.7	48.2	179.9
1965	21.91	23.31	72.8	264.7	54.0	196.4
1966	24.05	25.32	66.2	235.6	60.3	214.6
1967	19.69	20.51	57.9	203.2	63.1	221.4
1968	19.52	21.69	51.0	191.0	65.1	243.8
1969	23.89	26.54	46.5	173.5	65.9	245.9
1970	21.95	21.95	56.3	189.6	70.9	238.7
1971	18.45	17.08	80.4	250.5	74.4	231.8
1972	26.67	22.41	103.8	294.1	82.5	233.7
1973	40.27	28.36	142.1	337.5	120.1	285.3
1974	35.12	20.07	148.2	283.9	77.8	149.0
1975	48.32	23.92	78.5	131.3	43.7	73.1
1976	43.11	20.93	82.1	135.0	62.1	102.1
1977	41.07	18.42	95.0	143.9	56.7	85.9
1978	48.50	18.95	95.7	122.5	77.6	99.4
1979	42.42	14.53	177.9	198.8	166.5	186.0
1980	39.55	12.13	219.2	219.2	168.5	168.5
1981 January–June	—	—	208.1	—	150.5	—

[a]Barrows and Gilts, Chicago, liveweight.
[b]F.o.b. unit value of frozen boneless manufacturing beef exports to EEC.
[c]Australian oxen, 301–350 kg, bone in, wholesale, Brisbane.

Table 6. International corn prices (U.S.$/t).

Year	Argentina[a]		United States[b]	
	Current $	1980 constant $	Current $	1980 constant $
1950	68.6	333.0	68.1	330.6
1951	104.4	424.4	72.0	292.7
1952	105.0	416.7	62.6	248.4
1953	78.5	327.1	60.2	250.8
1954	73.3	310.6	58.3	247.0
1955	81.6	340.0	48.8	203.3
1956	80.7	328.1	51.6	209.8
1957	73.0	284.1	47.6	185.2
1958	58.4	215.5	47.6	175.7
1959	58.4	226.4	46.1	178.7
1960	59.5	225.4	43.3	164.0
1961	59.1	223.0	45.9	173.2
1962	57.3	218.7	51.4	196.2
1963	64.8	245.5	54.7	207.2
1964	66.6	248.5	55.8	208.2
1965	72.8	264.7	55.0	200.0
1966	72.0	256.2	59.4	211.4
1967	51.1[c]	203.9	49.9	175.1
1968	60.9[c]	228.1	49.1	183.9
1969	66.1[c]	246.6	53.9	201.1
1970	68.9	232.0	58.4	196.6
1971	66.7	207.8	58.4	181.9
1972	71.6	202.8	56.0	158.6
1973	119.3	283.4	98.0	232.8
1974	158.7	304.0	132.0	252.9
1975	154.1	257.7	119.6	200.0
1976	138.9	228.5	112.4	184.9
1977	114.4	173.3	95.3	144.4
1978	132.5	169.7	100.7	128.9
1979	154.8	173.0	115.5	129.1
1980	199.6[c]	199.6	125.5	125.3
1981	198.0	—	142.9	—

[a]Up to 1969, yellow, La Plata, parcels, c.i.f. Liverpool and London; 1970 onward c.i.f. Rotterdam for 30–60 days delivery; 1973 onward, c.i.f. North Sea ports.
[b]No. 2 yellow f.o.b. Gulf Ports.
[c]Partly estimated.

mestic currency terms at the border. Exchange rate movements and transport costs can change the complexion of the world market considerably. This is partially demonstrated by representative world beef and corn price data expressed in four real domestic currency units in the region. These series are not border prices and include only exchange rate effects. It will be noticed that although there appears to be a strong relationship between the prices denominated in dollars and domestic currency units, there are significant differences. The common element is exchange rate policy itself but even for these countries, the relationship is not one to one (Table 8).

International Market Implications for Sector Strategies

At the outset, it was stated that international market performance indicators provide useful benchmarks for livestock sector project evaluation. This includes border prices derived from the world price as indicators of opportunity cost. However, some elaboration may be required to prevent misunderstanding.

Policy development is often a team effort in which public and private analysts interface with the policymakers and their senior policy advisors on an in-

Table 7. International soybean and soymeal prices.

Year	Soybean (U.S.)[a]		Soybean meal (U.S.)[b]	
	Current $	1980 constant $	Current $	1980 constant $
1950	114	554	95	461
1951	145	592	125	508
1952	112	445	100	397
1953	119	496	108	450
1954	122	517	89	377
1955	111	464	77	321
1956	116	473	76	309
1957	106	412	78	304
1958	95	351	74	273
1959	94	364	73	283
1960	92	348	81	307
1961	111	419	97	366
1962	100	382	89	340
1963	110	417	91	345
1964	110	410	89	332
1965	117	425	97	353
1966	126	447	107	381
1967	112	393	99	347
1968	106	397	98	367
1969	103	384	95	354
1970	117	394	104	350
1971	126	393	105	327
1972	140	397	129	365
1973	290	689	302	717
1974	277	531	184	352
1975	220	368	155	259
1976	231	380	198	326
1977	280	424	230	348
1978	268	343	213	273
1979	298	333	243	272
1980	296	296	262	262
1981				
January–June	308	—	268	—

[a]U.S. No. 2, bulk, c.i.f. Rotterdam.
[b]Rotterdam, 44% c.i.f.

teractive basis.[2] The policymakers themselves may not have a clear picture of the balance of weightings that Cabinet has for the various societal groups that will be affected by a sector development strategy. Indeed it is reasonable to assume that it is difficult for an individual Cabinet Minister to forecast such weightings for some future time when the highest level decision is to be taken. In technical terms, this means that at the outset of the analysis, the national welfare function is not revealed to the analysts and may not be predictable by the Minister. Opportunity costs and the relative (economic) efficiencies of alternative strategies ought to be viewed as positive, rather than normative concepts. As such world market prices say nothing about what national policy ought to be. They are simply a statement of what is fact. For example, if the Republic of Korea can produce television sets in export quantities for x currency units per set and Canada can produce the same sets for y currency units and y is greater than x, then the opportunity cost of a Canadian policy to marginally increase domestic television set production is x currency units per set. In the absence of exchange rate, labour and capital market distortions, and transaction costs such a policy would impose an efficiency loss on the Canadian economy of y − x currency units per set.

[2]The approach being used by Professor Shim (this volume) and his associates in the IDRC Korean livestock development project is a good case in point.

In agricultural markets, however, there are added complications. Governments commonly strive to improve economic stability. For this reason they will be averse to risks associated with supply and price instability in the world market. Jabara and Thompson (1979; 1980) have shown that this concern implies that the optimal policy can involve positive intervention in the form of a variable levy (export tax). The argument is framed narrowly within the confines of the small country assumption. I have suggested that there may be rational motives for such intervention based on political consideration like the North–South discussion. Furthermore, this concept reinforces a positive approach to sector analysis, because it inevitably involves a judgment call (Lattimore 1981).

Another aspect concerns the objective of food security. Efforts to increase the level of self-sufficiency in livestock production can reduce the level of self-sufficiency in livestock feeds. New technology, land tenure systems for community pastures, and other adaptations are capable of relaxing this tradeoff. Nevertheless, where there is a significant tradeoff, it complicates the pursuit of the food security objective.

It is common to encourage the importation of livestock as part of such strategies. Under some circumstances this strategy can result, at best, in the substitution of imported animals for domestic animals, which are used for immediate consumption — it can be an expensive way of purchasing livestock products.

The food security objective is more than an attempt to reduce a country's exposure to the world market and lead to foreign exchange savings. Usually there is a tradeoff between equity and efficiency. Policy is seldom, if ever, solely concerned with efficient growth. This presents a major difficulty for analysts, because there is often a tradeoff involved between pursuing efficiency and equity goals. Nevertheless, it is crucial for value-free analysis that we understand the differences between these objectives and recognize the tradeoffs involved.

Conclusion

International markets are important in analyzing livestock development strategies for two reasons. First, in countries that are less than self-sufficient in livestock products or animal feedstuffs, world markets are an important source of product to balance domestic demand. However, because these markets tend to be volatile with few buyers and sellers, it is postulated that there is a high payoff associated with increasing public information systems related to these international markets. To do this effectively requires a major thrust by universities and research institutions to increase public understanding of the behaviour of these markets from a national

Table 8. Real world corn and beef prices (thousands domestic currency units, 1975).[a]

	Corn				Beef			
	Thailand (Bhat)	Philippines (Pesos)	Korea (Won)	Indonesia (Rupiahs)	Thailand (Bhat)	Philippines (Pesos)	Korea (Won)	Indonesia (Rupiahs)
1965	21	6.0	55	—	27	7.9	722	—
1966	21	6.1	53	—	24	6.8	587	—
1967	17	4.9	40	850	20	5.7	469	986
1968	17	4.7	37	508	17	4.8	383	527
1969	18	5.0	39	488	15	4.3	333	418
1970	19	7.8	38	538	19	7.6	363	520
1971	19	6.8	39	566	27	9.4	539	780
1972	18	6.3	36	511	33	11.6	666	947
1973	26	9.5	61	682	38	13.8	882	990
1974	28	10.1	80	654	32	11.3	898	734
1975	24	9.0	58	497	16	5.9	380	327
1976	22	7.9	47	390	16	5.7	344	285
1977	17	6.1	36	298	17	6.1	361	297
1978	17	6.0	34	437	16	5.7	319	416
1979	18	5.8	33	422	27	9.0	501	649
1980	16	5.5	37	378	28	9.6	654	661

[a]Nominal world market prices expressed in national currency units per tonne and deflated by the consumer price index.
[b]Price U.S. corn No. 2 yellow gulf ports/tonne (1975 = 100).
[c]Export price Argentina frozen boneless destined EEC, f.o.b./kg. (1975 = 1.0).
Source: Commodity Prices, World Bank 1981 and International Financial Statistics, IMP, various issues.

perspective — such information is not directly transferable from other countries. The second implication is that countries have a role in international consultative and negotiating commodity fora like the Group of 77, the Food and Agriculture Organization of the United Nations, (FAO), commodity organizations, the United Nations Conference on Trade and Development (UNCTAD), and the General Agreement on Tariffs and Trade (GATT) to the extent of their participation in world markets. Furthermore, countries have a major stake in ensuring that existing institutions effectively address their concerns.

On the policy evaluation front, international market relationships are a useful guide to efficiency gains and losses, provided that appropriate adjustments are made within the national context. Simple border pricing exercises will normally prove to be too simplistic for policy development. The required adjustments will come from a thorough understanding of the working of the world markets in question and a recognition of the benefits and costs associated with exposure to them.

Discussion Summary

Theodore Panayotou

Why, unlike the subsidized farmers in the U.S. and Europe, are the farmers in developing countries often taxed? A number of explanations were offered. First, agriculture, including livestock, in developing countries is the easiest sector from which to collect taxes because agricultural products pass through government-controlled marketing boards. It is also relatively easier for food-exporting developing countries to collect taxes at the point of export. As new sources of taxes (such as sales and income taxes) become operationally feasible the burden on agriculture is reduced. Second, taxation of the agricultural sector is a means of extracting the agricultural surplus necessary for the development of the industrial sector. A third view was that the main reason is the greater political power wielded by the urban consumers compared with the rural producers; urban consumers pressure the government to keep down the cost of food through price controls and export taxes.

Self-Sufficiency in Livestock Products

Should a country without an apparent comparative advantage in livestock production attempt to achieve self-sufficiency or import livestock products at the world market price? Many views were expressed both in favour of and against self-sufficiency in livestock products. Those in favour argued that self-sufficiency helps save scarce foreign exchange, boosts domestic employment and incomes, helps keep the rural population from migrating to the cities, provides security in strategic commodities in case of crisis or instability in world markets, and generally reduces a country's dependence on and vulnerability to conditions beyond its control. Those opposing self-sufficiency felt that many of these arguments were fallacious. First, the term "self-sufficiency" is meaningless unless one defines a specific price at which self-sufficiency is desired, because the domestic demand for agricultural products is a function of price. This is a particularly serious criticism, especially in the case of meat in such countries as Korea, where the demand for meat is price elastic (see Cho, this volume). Another criticism was that, to achieve self-sufficiency, countries without comparative advantage in livestock production would have to import most of their feedstuffs anyway. Feedstuffs being bulkier than meat or milk, have a higher unit transport cost; therefore, there is no net saving in foreign exchange or any reduction in the country's dependency on external markets. It was also pointed out that the efficiency losses of a protected industry are usually so high (e.g., 100% in the case of milk production in Korea) that they may outweigh possible distributional benefits. Besides, there should be alternative sources of employment and income. However, it was argued that developing countries resort to protectionist policies in reaction to the protectionist policies of developed countries. Why do international agencies urge

developing countries to lower trade barriers when they cannot expand their exports to the highly protected markets of the developed countries? A compromise position suggested that some forms of protection may serve a useful purpose in the short-run. For example, protective policies to achieve some degree of "self-sufficiency" in the country's main staple, which is likely to be price inelastic, may be justified in terms of security in a strategic commodity. However, livestock products can hardly be termed "staples." Yet, a country perceiving a threat to its national security may decide to "buy" national security at the cost of a protected, highly inefficient livestock industry; even then, alternative means of achieving the same result at lower cost should be considered. Theoretically, it is to the advantage of a "small" country to set the domestic price of a particular commodity somewhat higher than the world price to reduce its imports and, hence, its vulnerability to world price fluctuations by lowering imports and domestic demand and creating additional domestic supplies. Temporary protection may be used to "buy time" until more efficient sources of income and employment can be created. However, protectionist measures are extremely difficult to remove or even reduce once they have been introduced.

Livestock Projects and Foreign Experts

One subject that was discussed extensively relates to the performance of livestock projects, especially those that were supported by international development agencies and particularly the World Bank. What has been the degree of success of livestock projects? What accounts for the failures? What has been learned?

It was stated that World Bank evaluations show that livestock projects have relatively low success rates, and have the lowest rate of return of any sector. Many hypotheses were advanced by the participants (some of whom participated in project evaluation) to explain the relatively high degree of failure. Livestock projects are necessarily long-term and, therefore, have a considerable turnover in personnel. Other participants suggested that livestock intensification projects in many cases may have been only marginally profitable or not profitable at all, or that the farmers adopted only part of the package of new inputs and technologies which was not profitable, even though the entire package might have been. Another reason may have been that the new, more intensive technologies demanded better management skills that the farmer did not possess and that were not supplied by the project. Traditional pastoralist communities in Africa have reacted negatively to projects that attempted to confine them to particular areas. Insufficient knowledge of pastoral grazing habits and a shortage of management skills may lead to an overgrazing of communal pastures. In Nepal, among the factors responsible for the poor performance of livestock projects were the lack of expertise and of familiarity with local conditions by project experts. A Nepalese administrator provided examples of contradictory advice being offered by different experts. The Nepalese projects also suffered from inadequate funds and a lack of continuity. Other participants pointed to unrealistic project objectives, lack of motivation, and the paucity of local research capability for policy analysis and project appraisal. However, not all livestock projects performed poorly and examples of successful livestock projects in India and Indonesia were cited.

The Relevance of Academic Models for Policy, the Role of Universities, Domestic Research Capability, and Research Priorities

Questions were raised concerning the relevance and usefulness of academic livestock models, such as those presented in the preceding session, to livestock devel-

opment in developing countries. A policymaker from Nepal expressed the view that such models have limited usefulness as they stand because they are based on individual farmer behaviour, whereas in Nepal (and possibly in other developing countries) the relevant unit is not the individual farmer but the village farming system where there is a role for all farmers. Moreover, the cultural background, e.g., caste, plays an important role in decision-making. There is a need to develop models for the integrated village farming system within the relevant cultural framework. Related questions were asked regarding the role of universities in livestock research in developing countries. For example, how much has been done at the universities to develop nonconventional sources of feed and to educate the farmer on the nutritive value of such feeds and encourage the use of low-cost feed formulations? Some participants argued that livestock research is underfinanced in comparison to crop research because the livestock farmer does not see the same direct connection between research and profits as in the case of crops. Others have pointed to a shortage of analytical capacity in the social sciences and recommended a considerable training and research effort. Several research priorities were suggested including production, consumption, and marketing studies as well as policy analysis.

Policy Choices

Livestock Development in Korea: Issues and Policies

Young Kun Shim[1]

Abstract. Traditionally, Korean agriculture has centred on the production of rice and other cereals, and the livestock sector has been ignored as an industry. As a result of rapid economic growth, the rise in income has stimulated a major increase in the consumption of animal protein, and Korean agriculture is faced with a number of crucial adjustment problems. Domestic production has not kept pace with demand because of limited feed, land, and capital constraints. This supply shortage is projected to increase in the future. Rapid development of the livestock industry is, therefore, becoming increasingly important as a component of Korean agriculture. However, most of Korea's small-scale farmers cannot make the necessary adjustment by transferring their limited farming resources from cereal to livestock production.

To meet current market demand, the government has initiated various measures including the provision of institutional loans, importation of meat and dairy products, paying subsidies for reclaiming grassland, extension services for breeding and raising cattle, livestock marketing activities to stabilize prices, regulations to offset losses from investing in livestock farming, and so forth. To date, such government policies have not been very effective in alleviating the constraints faced by the industry, because they reflect a response only to the immediate situation without adequate consideration of related problem areas. Thorough and comprehensive analysis is required to formulate effective, longer-term policies.

Résumé. Traditionnellement, l'agriculture coréenne se concentrait sur la production de riz et d'autres céréales, tandis que l'élevage professionnel du bétail était négligé. Mais, la croissance économique atteignant un rythme rapide, l'amélioration des revenus a provoqué une augmentation très importante de la consommation de protéines, ce qui place l'agriculture coréenne face à de nombreux problèmes d'adaptation. La production nationale n'a pas suivi le rythme de la demande en raison des contraintes posées par la quantité limitée de nourriture animale, de terres et de capitaux disponibles, situation qu'on s'attend à voir s'aggraver à l'avenir. Il devient donc de plus en plus important que l'élevage du bétail progresse et devienne partie intégrante de l'agriculture coréenne. Malheureusement, la plupart des petits fermiers coréens sont incapables d'appliquer à l'élevage les modestes revenus provenant de la production de céréales.

Le gouvernement n'est pas resté inactif. Pour faire face à la demande du marché, il a pris diverses mesures : prêts institutionnels, importations de viande et de produits laitiers, subventions à l'aménagement de pâturages, vulgarisation des méthodes d'élevage, interventions pour stabiliser les prix, règlements visant à compenser les pertes subies en investissant dans le bétail, etc.

A ce jour ces mesures n'ont guère réussi à alléger les difficultés rencontrées par les éleveurs, parce qu'elles se contentaient de parer à l'immédiat sans prendre en compte l'ensemble des problèmes. Il s'impose d'effectuer une analyse globale et approfondie pour élaborer une stratégie de développement rationnel, à long terme.

In 1980, 66.4% of the total area of 9.9×10^6 ha in South Korea was classified as forest land on mountainous topography, and only 22.3% was classified as arable. In spite of the low percentage of total area currently used, there is not much room for expanding the cultivable land base. Moreover, the cultivated land area has limited year-round potential use because of topographic, climatic, and cropping pattern factors as well as economic constraints.

For the nation as a whole, about 2.2×10^6 ha was cultivated in 1980. Of the cultivated area, 59.5% was classified as paddy field and 40.5% as dry land based on availability of irrigation facilities. Different cropping systems exist for each of the two types of land. All paddy fields produce mainly rice during the summer, and dry lands are used for variety of coarse grains, vegetables, fruits, and industrial crops. Only

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about 25.3% of the arable land was double cropped.

In 1980, the total farm population was about 10.8 million. The proportion of the farm population to total population was 28.4%, and total farm households numbered 2.2 million. The average farm has only about 1 ha of land, and each farm family has about five members. Farming methods are based primarily on human and animal power. Of course, there are a number of new technologies available that substitute for labour and embody potential productivity increases. However, adoption of new technology by farmers is limited not only by cash constraints but also by lack of familiarity with the new techniques. Thus, farming over the years seems to have changed little.

Because the available cropland is limited, food grain production has been emphasized. In 1980, 79.9% of the total value of farm production at current market prices was generated by food crop cultivation. Livestock and livestock products and cocoons played a minor role as they accounted for 19.3% and 0.8% of the total value, respectively. Rice is the most important food crop accounting for 43.1% of the total value of food production. Next to rice, barley and wheat account for 5.2% followed by potatoes, pulses, and miscellaneous grains in that order.

As a whole, agricultural productivity has grown at an average yearly rate of 2.4% in real terms from 1962 to 1980. This increase was mainly due to government rural development programs aimed at increasing rural income and achieving a high level of national self-sufficiency in food grains. Nevertheless, total production of food grains has remained far below the levels that would adequately satisfy demand.

The self-sufficiency ratio for domestic food grain production was as high as 93.9% for all grains in 1965. It has since decreased to 54.3% in 1980, mainly because of increases in both population and per-capita income. The self-sufficiency ratios for rice and barley in 1980 were 88.8% and 57.6%, respectively. The ratio was particularly low in wheat and corn with only 4.9% and 5.9%, respectively. At present, only the domestic production of potatoes and fruits exceeds internal demand (Table 1).

To supplement this shortfall, imported grain has been necessary for many years. In 1980, total grain imports of 5.1×10^6 t of grain consisted of 2.3×10^6 t of corn, 1.8×10^6 t of wheat, 0.6×10^6 t of rice, and 0.4×10^6 t of soybeans. The value of these imports totaled U.S.$1021 million. In addition, U.S.$400 million of livestock was also imported. This combined amount was equivalent to about 30% of Korea's trade deficit of U.S.$4.8 billion in 1980. Moreover, these trends are likely to continue in future.

Issues in the Livestock Industry

As per-capita income and population have grown, especially in urban areas, changing dietary preferences have led to a relatively higher growth in the consumption of animal proteins than for cereals and vegetables. Because emphasis has been placed on rice and barley production, national policies have made grain production relatively more attractive for farmers than livestock production.

Increases in Consumer Demand

Total consumption of meat increased from 165 063 to 432 682 t between 1970 and 1980, and per-capita consumption from 5.2 to 11.3 kg. These data indicate a relatively high rate of increase compared with other Asian countries where incomes have not grown as fast, but consumption still remains below the level prevailing in Japan (Table 2). This increase in demand for meat and dairy products caused new adjustment problems for Korean agriculture, which has historically been based on crop cultivation. The economic issue is how to meet the growing demand for dairy products, meat, and feedstuffs in the most efficient manner possible.

Inefficient Marketing Systems

The meat, dairy product, and feedstuff markets are not only new in contrast to other product markets in Korea but the organization and structure of the meat market is very different from other Korean commodity markets. Recently, the amount of livestock products and feedstuffs that must be transported internally has increased greatly, but the marketing facilities and infrastructure have not expanded as fast as the growth in domestic production and imports.

Retailers of meat and dairy products have very small operations, and use small amounts of capital. The present distribution system has evolved in an effort to handle the increased amounts of livestock products and feed, but the system suffers from inefficiency, structural awkwardness, and imperfect performance. Accordingly, the marketing cost is considered high compared with the level of services provided.

Domestic Production Shortages

Although the production of livestock products and meat has increased, it has not kept up with the demand mainly because of the limited availability of feedstuffs and the relatively low market prices for livestock products. Virtually all arable land is now

Table 1. Self-sufficiency ratio (%) in various food crops, 1965–80.

Year	All food crops	Rice	Barley	Wheat	Corn	Potatoes	Soybean
1965	93.9	100.7	106.0	27.0	36.1	100.0	100.0
1970	80.5	93.1	106.3	15.4	18.9	100.0	86.1
1975	73.0	94.6	92.0	5.7	8.3	100.0	85.8
1976	74.1	100.5	97.9	4.5	6.7	100.0	74.4
1977	65.1	103.4	53.4	2.3	6.2	100.0	67.5
1978	72.6	103.8	119.9	2.1	6.0	100.0	59.3
1979	59.8	85.7	117.0	2.4	3.4	99.8	43.4
1980	54.3	88.8	57.6	4.8	5.9	100.0	35.1

Source: Ministry of Agriculture and Fisheries, agricultural statistics, 1981.

Table 2. Total consumption of meat and livestock products compared with income level per capita, 1964–80.

Year	Income per capita (U.S.$)	Consumption per capita (kg)			
		Meat	Beef	Pork	Chicken
1965	106	3.44	0.96	1.97	0.51
1968	168	4.31	1.17	2.03	1.11
1971	266	5.25	1.22	2.49	1.54
1973	361	5.63	1.37	2.69	1.58
1975	532	6.37	1.99	2.80	1.58
1976	698	6.85	2.11	2.95	1.70
1977	864	8.12	2.24	3.88	2.01
1978	1297	10.13	3.10	4.81	2.22
1979	1597	11.33	3.01	5.96	2.36
1980	1508	11.33	2.62	6.33	2.38

Source: National Livestock Cooperative Federation statistics, 1981.

devoted to growing food grains, so there is a serious shortage of land for pasture and fodder crops. Therefore, most subsistance farmers feed livestock with by-products from food grain production, use unimproved hillside or riverbank grass, and purchase commercial feeds. These farmers have not been very sensitive to market prices in adjusting their livestock production, and due to lack of available capital and other resources, these small-scale farms will not be able to contribute greatly to an increase in total livestock production.

Recently, the prices for beef, pork, and poultry have increased yearly. Therefore, rather than expanding the number of livestock raised on traditional farms, several large-scale, specialized farms have been established. Although there are still few of these large farms, their production has had a substantial effect on market prices. Such farms generally do not produce feedstuffs but rely on commercial feeds processed largely from imported feedgrains. The commercial farms can expand the industry by enlarging their scale of farming and through future increases in the number of such enterprises. However, projected production increases from such ventures will not satisfy future demand.

High Price of Feed

The need for more feed production encouraged the government to reduce imports of finished products rather than feed grains. Nevertheless, the supply–demand imbalance is expected to worsen unless more feed processing plants are built. If these logistical and infrastructure problems are solved, Korean farmers will obtain more of the proper types of commercial feeds at the right time and at lower costs. This would increase the total production of livestock products substantially.

The construction of feed plants and slaughterhouses is regulated by the Korean government. In addition, the government controls the production of commercial compound feeds by rationing feed grains. These measures may help encourage the expansion of production capacity, but government policies have not provided the processors with incentives to use cost-saving technology because the prod-

ucts can be sold easily. Government policies must attempt to reduce processing costs to be competitive with world market prices.

Foreign Exchange Requirement

The projected demand for all meat is estimated at about 1.1×10^6 t by 1990 up from 0.5×10^6 t consumed in 1980. This implies increases in feed grain imports from 3×10^6 t in 1980 to 9.6×10^6 t by 1990. However, this rapid growth in imports will be a heavy burden on the national economy in terms of foreign exchange requirements.

If the livestock sector is to grow, there seems to be no alternative than to increase the supply of feed grains. Otherwise, meat, dairy, and poultry production will become very inelastic over the long term.

Policies for the Livestock Industry

Production Policies

The government has given high priority to the development of the Korean livestock industry to alleviate the serious and growing gap between domestic consumption and production. Beef production takes a much longer time than pork and poultry production to respond to the ever-increasing demand. However, the number of cattle has gradually decreased during the last few years. The main reasons include a decrease in the number of draft animals due to the increasing use of mechanical tillers, difficulties in grazing on wild grass because of a reduction in farm family size, and low returns from raising cattle. In 1981, the government initiated measures to increase production. These included: institutional loans at a low rate of interest to about 30 000 small-scale farmers for livestock production, importation of 11 200 beef cattle and distribution to farms located in mountain areas on a credit basis, and the dissemination of hybrid beef cattle to increase beef production. Other policies to increase the production of feedstuffs included: long-term loans to reclaim marginal land for forage and feed crops production (in 1981, about 3200 ha had been reclaimed), and technical assistance for effective use of rice-straw as roughage and for planting forage crops on paddy fields as a second crop after the fall rice harvest.

Price Policies

The price of meat has increased continuously, particularly for beef, which has increased over 9-fold during the last 10 years. The price for pork and chicken has increased about 6 and 2.5 times, respectively. It is interesting to note that the price ratio between beef and pork declined from 54% in 1970 to 42% in 1980 (Table 3).

The price of meat and dairy products has fluctuated periodically because of cyclical changes in production, a vulnerable price mechanism, insufficient imports, and inefficient marketing channels. To stabilize price levels, particularly for beef and pork, the government is directly involved in determining price levels on the retail market. In 1980, the government was importing 24 000 t of beef, which was equivalent to 24.6% of the total demand of 97 594 in 1981. Nevertheless, the wholesale market price levels fluctuated widely during the year. The range of price fluctuation was very high for pork and beef, 77.1 and 26.1%, respectively (Table 4).

Price stabilization is obtained by adjusting supply through the release of imported beef on the market. All retailers must sell beef at a fixed price set by the government. Retailers usually adjust to price in-

Table 3. Wholesale prices of livestock products, all urban areas, 1970–80.[a]

Year	Boneless beef (Won/600 g)	Pork (Won/600 g)	Chicken (Won/kg)	Eggs (Won/10)
1970	392	211	517	124
1971	508	297	548	115
1972	601	300	487	124
1973	653	338	588	148
1974	780	415	842	188
1975	876	570	1072	242
1976	1297	807	1474	258
1977	1691	843	904	287
1978	2209	1185	1010	306
1979	2480	1133	882	289
1980	2922	1238	1301	369

[a]Won 700 = U.S.$1.00.
Source: National Livestock Cooperative Federation statistics, 1981.

Table 4. Consumer price and monthly price indexes of beef, pork, and chicken at all urban areas, 1980 (Won/600 g).[a]

Month	Beef		Pork		Chicken	
	Price	Index	Price	Index	Price	Index
Jan	2497	87.2	910	70.1	1079	84.3
Feb	2432	84.9	1140	87.8	1386	108.3
Mar	2753	96.1	1178	90.7	1615	126.2
Apr	2837	99.0	1027	79.1	1446	113.0
May	2839	99.1	1036	79.8	1136	88.8
Jun	2849	99.4	1159	89.2	1030	80.5
Jul	2849	99.4	1190	91.6	1047	81.8
Aug	2897	101.1	1305	100.5	1122	87.7
Sep	3040	106.1	1404	108.1	1221	95.4
Oct	3045	106.3	1529	117.7	1312	102.5
Nov	3160	110.3	1800	138.6	1452	113.4
Dec	3181	111.0	1912	147.2	1520	118.8
Average	2865	100.0	1299	100.0	1280	100.0

[a]Won 700 = U.S.$1.00.
Source: Economic Planning Board, monthly statistics of Korea, 1981.

creases in the wholesale market by mixing different cuts of beef. Thus, consumers buy at a fixed price, but the quality of meat declines when wholesale prices increase.

Korean consumers prefer native beef cattle to imported cattle because of the generally low-grade of meat imports. To cut consumption, the government has established a dual price system for beef by raising the price of local beef. The current price of imported beef has been set at 3000 Won/600 g, and the local beef is priced at 4200 Won/600 g (700 Won = U.S. $1.00). Although the local beef price is 40% higher than that of imported beef, consumers, particularly the high income group, have not responded to this price difference.

Policies have also been implemented to stabilize the price of pork and poultry. Compared with cattle, it is much easier to increase the number of hogs and chickens, and over the past 2 years pork prices have been favourable for producers so not only farmers raised more pigs than before, but also a number of large farms have been established as agribusiness enterprises. These producers have a strong influence on market prices. In 1981, their production accounted for 37% of all hogs and 92% of all poultry marketed. Marketings have been uneven through the years and have caused large fluctuations in market prices. If prices drop below government-fixed lower limits, the government cannot buy all of the oversupply and store it because of the high storage costs. Thus, farmers sometimes complain that no policies exist for the livestock industry in Korea. Certainly, there are a variety of policies to improve the industry, but they have not always been as effective as had been hoped.

Trade Policies

Live cattle for breeding and beef production, meat and dairy products, and feedgrains all require government permission for import. This enables the government to control the quantities to be imported at a low tariff rate. Due to the trade deficit in the balance of payments it is sometimes difficult to import the livestock products in accordance with ever-increasing marketing needs. On the other hand, the government paid subsidies to certain companies to promote a negligible amount of livestock exports.

Conclusion

In the face of increasing demand for meat and other livestock products, domestic production has been expanded but at a slower rate than demand, and, as a result, a series of issues has surfaced. The economic problem is how to meet the growing demand for livestock products and feedstuffs and combat the shortage of basic food grains in the most efficient way possible. In the past, the Korean livestock industry has been a by-product of the small farm enterprise, but this situation must be reexamined. The problems of the livestock industry are not only new but are complicated by their interrelationship with other agricultural development issues.

Policy considerations include stabilizing market prices, improving market access, reforming inefficient marketing systems, coping with the shortage in domestic production, inadequate processing, high prices of feedstuffs, and constraints on increasing imports of feed grains and livestock products. The

government has promulgated a series of policy measures to increase production that include providing institutional loans to small-scale farmers to raise livestock, paying subsidies for reclaiming pasture, providing extension services for technical guidance in livestock production, lowering tariffs on imported feedstuffs, exempting dairy breeding stock from tariffs, fostering commercial farms, expanding market facilities, and controlling prices at the retail market.

The government exercises a strong influence through its regulation of retail prices, operation of meat markets, and import quotas. Nevertheless, actual price levels have fluctuated more widely than had been planned for. The main reason for price controls is to minimize welfare losses to consumers from price hikes. However, this policy limits incentives to producers and, thus, restricts higher rates of production.

On the other hand, increased production of livestock products requires a continued increase in imported feed grains. However, imports become a heavy burden on a national economy already saddled with a trade deficit of about U.S.$5 billion each year. Even if these deficits in foreign exchange decline as a result of continued economic growth, Korea will not be able to import sufficient quantities of feedstuffs, and the shortages will remain.

Because of the many diverse issues facing the livestock industry in Korea, it is necessary to identify the groups and firms that make up the market, the available stocks of feed and livestock, patterns of consumption, and the key elements of the decision-making process. A major deficiency is the lack of analyses of consumer demand and farmers' supply responses to price as well as problems in the production, distribution, processing, and trade in feedstuffs and livestock products. Government decisions at present are frequently dominated by responses to the current situation without adequate knowledge of the industry and market. Thus, current policies often present a sequence of trial and error. The future effectiveness of government policies depends on plans that are based on more adequate data about the livestock sector.

Livestock Development Policy In Indonesia

Herman Soewardi and Didi Atmadilaga[1]

Abstract. The main constraints and potential of livestock development within the existing agricultural ecosystem in Indonesia are discussed. Among the main issues identified are: (a) Java has limited livestock carrying capacity due to population density; (b) consumer demand for meat puts a heavy stress on the existing livestock population, beyond its reproduction rate; (c) the subsistence agricultural sector is inadequate to support quick-yielding egg and broiler production as a substitute for beef in which concentrate is competitive with direct consumption; (d) a decrease in the number of large ruminants has caused a shortage of draft power and encouraged the use of small tractors, which affects the earning opportunity of farm labourers; (e) the less densely populated outer islands of Java, offer room for increased livestock carrying capacity; (f) domestic production of milk constitutes only 10% of consumption; (g) importation of livestock to offset the alarming drain on the existing livestock population cannot be effective unless strict measures are taken to prevent overslaughtering. The following policy measures are recommended: increase the carrying capacity of Java in the agricultural sector, establish cattle ranches in the outer islands, substitute beef with broilers, increase milk production, and provide more effective and substantial financial assistance.

Résumé. On trouvera dans ce texte des considérations sur le potentiel de développement du bétail et sur les principaux facteurs limitants de l'écosystème agricole actuel en Indonésie. Voici les plus importantes des questions traitées : a) Java a une capacité d'élevage limitée en raison de la densité de sa population ; b) la demande de consommation de viande est forte et pèse lourdement sur la population animale dont elle dépasse le taux de reproduction ; c) le secteur de l'agriculture de subsistance ne peut contribuer à la production intensive d'œufs et de poulets à rôtir en substitution du bœuf ; d) en raison de la raréfaction de ces bons animaux de trait que sont les grands ruminants, les fermiers se sont tournés vers les petits tracteurs, dont l'utilisation prive de leur salaire les ouvriers agricoles ; e) les îles du pourtour de Java, qui sont moins peuplées, se prêteraient à un élevage de bétail plus intensif qu'il ne l'est aujourd'hui ; f) la production nationale de lait représente seulement 10 p. 100 de la consommation ; g) l'importation de bétail, pour compenser l'alarmant épuisement de la population animale existante, ne peut être efficace que si de sévères mesures sont prises pour lutter contre un abattage excessif.

Les mesures suivantes ont été recommandées : augmentation de la capacité de Java dans le secteur agricole ; établissement de ranchs de bétail dans les îles avoisinantes ; substitution de la production de poulets à rôtir à celle du bœuf ; augmentation de la production de lait ; meilleure efficacité et augmentation de l'assistance financière.

In Indonesia, lands used traditionally as village community pastures are being transformed into agricultural lands for producing food crops to feed the growing population. In Java, practically no land is allocated for livestock, and free grazing of livestock is becoming more and more limited. A major problem is livestock feed, which is comprised of low-quality natural grasses. In certain parts of the country with vast areas of wet paddy fields, keeping water buffalo tends to be regarded as a burden, so that the buffalo population is declining steadily. Now Japanese-built tractors are beginning to take over gradually the function of the water buffalo as a draft animal. In future, the livestock shortage may worsen because of the need for land to grow food crops to meet consumer demand. However, there is also a growing demand for protein and livestock products in general. The implications of the previous neglect of this demand have already become evident.

The increasing per-capita income created a growing demand for livestock products, particularly since 1974, the beginning of the second Five Year Devel-

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opment Plan. This trend caused a heavy drain on the livestock population, because many productive female livestock were slaughtered for their high value as meat. As per-capita income continues to increase, so will the drain on the livestock sector. It is estimated that Indonesia's per-capita income will reach U.S.$500–600/year by 1990, which is an income level sufficient to change the consumption pattern to more animal protein. The Government of Indonesia is concerned and has increased the budget allocation for livestock development from 12.5 billion rupiahs (5.1% of the total agricultural development budget) during the second Five Year Plan to 97.8 billion rupiahs (6.4% of the total agricultural development budget) (as of 1982, Rp 645 = U.S.$1.00) for the third Five Year Plan. The livestock development policy for the third plan is to increase the production of eggs, meat, and milk to meet the growing demand and at the same time to raise the overall ruminant population by 1 or 2%/year. Production of corn, soybean, mung bean, rice bran, etc. is also to be increased accordingly.

The higher budget allocation for livestock development reflects a greater appreciation by government of livestock as a national asset, particularly as a source of animal protein. But livestock development is not an easy task, due to the complex nature of the agricultural sector. Java's agricultural sector places a strong emphasis on rice production, which limits the scale for livestock development, especially of large ruminants. Agricultural development policy also emphasizes a more equitable income distribution among the farmers. The consequences are that the price of corn, the chief source of animal feed, has to be raised to help corn producers. However, the higher price places egg and poultry producers at a disadvantage. Modern, efficient poultry farms are having to reduce their output to provide more room for backyard poultry farmers. Such tradeoffs are inevitable, but the task of the government will be to minimize their overall cost.

Potential of Traditional Livestock Production

Traditional livestock farming is an opportunity to exploit the low opportunity cost of farm labour. Livestock are also sources of draft power, manure, ready cash for emergencies, and are a mechanism for saving. Practically all the meat marketed commercially in Indonesia comes from traditional livestock production. The contribution of livestock to gross domestic product (GDP) in agriculture is 7.7% or Rp 215.3 billion (1977); that of agriculture to the national GDP is 33.7% or Rp 3034 billion.

The intermediate goals of national development are called *Trilogi Pembangunan*, and are aimed at achieving growth, equitable distribution of income, and national stability. In agriculture, these intermediate goals are to: increase self-sufficiency in carbohydrate food production (excluding wheat), while ensuring that the nutritional requirements of the consumers are being met; increase farmer income; expand employment opportunities; augment exports and decrease imports; support manufacturing through the provision of raw materials; preserve natural resources and improve and preserve the environment; and promote rural development. In terms of output, agriculture grew 5.6%/year during the First Development Plan (1969–73) and 2.9%/year during the Second Development Plan (1973–77). Cereal production rose steadily and now for the first time Indonesia faces the possibility of an overproduction of rice and corn.

These achievements were obtained through the "Bimas" or mass guidance program, which began in 1964 when Indonesia seriously began to pursue her food self-sufficiency policy. Advocates of intensification argued that increased production should come from raising yields on existing cultivated lands, particularly in Java. Their arguments were based on the results of a successful experiment conducted by the Bogor Agricultural University in 1963 where the farmers were guided and eventually persuaded to apply five improved practices in rice growing. The yields obtained by the participating farmers were at least 50% higher than on neighbouring farms.

The experiment was expanded in 1964–65 to cover 10^3 ha over about 200 villages as a "Demas" or mass demonstration program. The reported average yield obtained in the program was about 7 t of stalked paddy as compared with the national average of only 2.5 t. Therefore, the government increased the coverage of the program and adopted the Bimas or mass guidance program. Since then, the Bimas program has become the primary concern of the nation as a whole.

The basis of increased production has been intensification, i.e., raising the yield per unit of land. Intensification requires the application of new technology using modern inputs such as fertilizer, pesticides, improved seeds, new varieties, credit, etc., which are not produced on the farm. For the farmers, application of the new technology requires a major change in their behaviour. The supply of new technology and modern inputs is channeled through institutions, which must be created and grow in line with the farmer demand.

The "Improved Bimas" program began in 1970–71, and was characterized by delivery insti-

tutions that were very different from those used in the past. Services were and still are provided to the farmers through a cluster of villages called "village unit areas." In each village unit area four delivery institutions were created: the agricultural extension managed by a field extension worker, the private kiosk for channeling farm inputs (fertilizers, pesticides, seeds, etc.), the village unit bank to make credit arrangements to the farmers, and the village unit cooperative assigned to be the purchaser of farm outputs from the farmers. The four delivery institutions were basically new creations or were at least a big improvement over the existing ones. The village unit bank and the private kiosk were entirely new creations, whereas the field extension worker and the village unit cooperative were drastic improvements over old systems. The adoption of new practices for the production of food crops, including rice, corn, cassava, and beans, is now nation wide. Most farmers now rely on such modern inputs as fertilizers, pesticides, high-quality seeds, etc. As a result, there is now overproduction of some food crops, particularly rice and corn.

The development of livestock production has not been as successful. When the First Development Plan started in 1969, the livestock subsector was traditional in character. High-quality breeds of livestock and poultry were not available. Improved practices had still to be developed. As well, the lack of skilled personnel and veterinarians compounded these already immense technical constraints. Livestock's contribution of 5.8% to overall agricultural GDP was the lowest. The government initiated measures to modernize the livestock subsector primarily on the basis of nutritional considerations. These measures were aimed at encouraging the gradual transition from less-efficient traditional practices. The process involved the use of high-quality yearlings and day-old chicks, feed improvement, management improvement, livestock protection, and the supply of credit and improvement of marketing facilities. These efforts were synchronized in a program designated the "Bimas of Livestock," which in the first stage included egg production and the fattening of beef cattle.

Unlike the "Bimas of Food Crops," which is managed by an interdepartmental organization, the Bimas of Livestock is managed by the Directorate General of Animal Husbandry, and there are practically no formal links between these two organizations. The village unit area with its four delivery institutions, has no role in support of the Bimas of Livestock. However, the growth rate of livestock products during the First and Second Development Plan was encouraging, notably in the production of eggs. In this case, foreign investment has played a decisive role. Unfortunately, the Bimas of Livestock program could not arrest the drain on the livestock population, which occurred during the Second Development Plan. Since the beginning of the First Development Plan, modernization of livestock production has proven generally successful (Tables 1 and 2).

Relative increases in livestock production were among the highest in the whole sector during the period of the Second Development Plan. Foreign investments accounted for much of this increase especially in poultry through the provision of improved breeds and better-quality chicken feed. It was coordinated under the Bimas of Livestock program. The increase in meat production occurred primarily through the cattle fattening program, a section of the Bimas of Livestock program. Local breeds of cattle were penned in stables and subjected to improved practices for 3 months. Production of meat per head increased significantly. Milk production, however, was slow to increase. Milk imports were equivalent to more than half of domestic production and their value was third among agricultural product imports. Some have argued that slow progress in raising domestic milk production is inseparable from the milk import policy.

Table 1. Production of meat, eggs, and milk, 1974–77 ('000 t).

Item	1974	1977	% average increase 1974–77
Meat	403.1	408.9	5.2
Eggs	98.1	122.5	7.8
Milk ('000 L)	56.9	60.5	2.5

Source: Agricultural Third Development Plan, Department of Agriculture, 1979.

Table 2. Livestock population, 1974–77 ('000 head).

Item	1974	1977	% average increase 1974–77
Cattle	6380	6167	−1.1
Dairy cattle	86	98	4.2
Buffalo	2415	2222	−2.7
Goat	6517	7119	3.1
Sheep	3403	3710	3.0
Swine	2906	2976	1.0
Chicken (improved)	3450	5807	19.0
Chicken (unimproved)	89650	101689	4.3
Duck	13620	16032	5.6

Source: Agricultural Third Development Plan, Department of Agriculture, 1979.

Efforts to eliminate the drain on the livestock population were not very successful. The cattle, water buffalo, goat, and sheep population declined because of communicable diseases, shortage of feed, and particularly because of the overslaughtering of cattle, including females, in response to attractive retail prices. The goat and sheep population has since been increased.

The government hopes that the Third Development Plan will be a turning point in livestock development. The plan must be capable of fulfilling the rapid increase in consumer demand on livestock products, stabilizing the livestock population, contributing more to farmers' incomes, expanding employment opportunities, and promoting equitable income distribution. To meet these objectives the Directorate General of Animal Husbandry formulated the following development steps: (a) protection of existing livestock through prevention and study of diseases; (b) increase the livestock population and improve genetic quality through the provision of females and artificial insemination; (c) increase feed and improve feed quality through the provision and dissemination of forage grass and legume seeds; (d) increase attractive credit facilities and develop cooperatives; (e) increase extension services with farmers and livestock smallholders; (f) develop livestock enterprises, integrated with traditional livestock methods; and (g) improve other policy measures such as distribution of concentrates, veterinary drugs, and improve marketing and pricing policies. By these measures, it is hoped that the livestock population will increase at a net rate of 1–2%/year (Table 3).

The projection of the consumption and production of livestock products is given in Table 4. Domestic meat production will not satisfy projected demand. If imports are insufficient there will be a drain on the livestock herd during the Third Development Plan period. Imports of milk, to make condensed and reconstituted milk will also increase in this period.

Conclusion

- The agricultural sector of Indonesia should be studied further with an aim to increasing livestock production;
- There are programs that can be developed to give the basic support under traditional conditions;
- In Java, carrying capacity can be increased through a multiple cropping system that provides

Table 3. Projection of livestock slaughter and population increase (%).

Item	Death	Birth	Slaughter	Population increase
Beef cattle	1.6	17.6	15.0	1.0
Buffalo	2.2	12.3	10.0	0.0
Goat	4.7	56.7	50.0	2.0
Sheep	4.7	56.7	50.0	2.0
Swine	16.2	73.2	55.0	2.0
Dairy cattle	10.0	30.0	15.0	5.0

Source: Agricultural Third Development Plan, Department of Agriculture, 1979.

Table 4. Projection of consumption and production of livestock products, ('000 t) 1979–83.

	1979		1983		Average increase	
Item	Consumption	Production	Consumption	Production	Consumption	Production
Meat[a]	455.6	440.8	571.1	518.3	5.8	4.0
Eggs[b]	132.3	167.9	168.1	217.0	6.2	6.6
Fresh milk	68.2	76.1	94.6	106.3	8.5	8.7
Condensed milk	48.0	—	65.1	—	7.9	—
Dried milk	37.0	—	49.9	—	7.3	—

[a]Includes beef, buffalo, mutton, swine, and poultry.
[b]Includes chicks and ducks.
Source: Agricultural Third Development Plan, Department of Agriculture, 1979.

adequate farm waste and suitable nutrition for livestock feed. Other potential areas can be developed through the agroforestry program;

- The steady drain on the livestock population in Java could be made up through imported stock and wide application of artificial insemination. While attempting to meet the steadily increasing demand for meat over the longer term a rapid increase in the production of such substitutes as eggs and broilers should be encouraged. However, shortages of forage and concentrates restrict the ability to meet consumer demand. The alternative is to develop the substantial potential of the outer isles, particularly for ranching; and

- Recent measures including the promotion of the five principles of better farm management are improvements on past policies. These include effective extension services, increased and more attractive credit facilities, the development of livestock cooperatives, encouragement of large-scale cattle ranching in the outer isles, and controlled livestock imports. Promotion of increased fodder crop production and the development of a multiple cropping system are also important.

An Overview of the Livestock Sector in Thailand with Special Reference to Buffalo and Cattle

Ruangrai Tokrisna[1] and Theodore Panayotou[2]

Abstract. This paper provides an overview of the livestock sector and attempts to explain variations in the aggregate stocks of live animals, the domestic consumption of beef, and the exports of live animals through variations in prices, incomes, and other relevant variables. Because of its preliminary nature the study concludes with remarks anticipating policy implications to emerge from a more thorough study now under way.

Résumé. Ce document de travail s'intéresse au bétail en général et tente d'expliquer les variations dans les troupeaux d'animaux sur pied, la consommation domestique de bœuf et les exportations d'animaux sur pied à travers les variations de prix, de revenu et autres variables pertinentes. Cette étude est de nature préliminaire. Une étude plus approfondie en cours devrait déboucher sur des recommandations de politique commerciale.

Livestock, and within livestock buffalo and cattle, has been among the slowest growing sectors of the Thai economy. The decade covering the mid-1960s to the mid-1970s has witnessed the spectacular growth of the fishing industry that made plentiful supplies of animal protein available for both domestic consumption and export. The 1970s witnessed the remarkable growth of a number of livestock-related industries, such as feed crops (corn, sorghum, and tapioca), fish meal, and animal feed and under this stimulus the equally remarkable growth of poultry and, to a lesser extent, of swine production.

Buffalo and cattle production, however, remain virtually stagnant despite the fact that the demand for beef has been growing at the average rate of 5–6%/year, with consequent upward pressure on prices (Bank of Thailand, 1980 Annual Economic Report, p. 37). Given the rising beef prices and the availability of low-cost animal feeds, the lack of growth in buffalo and cattle stocks is surprising; more so, in the light of the quick response of Thai farmers to economic opportunity as demonstrated by their smooth switch between crops (eg., the switch from kenaf to tapioca in the Northeastern region). The government has been considering ways to promote the development of the buffalo and cattle industry to meet rapidly rising domestic demand and, thus, to halt the continuing increase in beef prices, as well as to take advantage of the substantial export potential to neighbouring countries (Hong Kong, Malaysia, and Singapore). Moreover, buffalo and cattle have the advantage of the highest domestic value added, estimated at 86%, among all types of livestock; for instance, the domestic value added for swine is 41% and for poultry it is 35% according to the National Economic and Social Development Board (NESDB).

Overview of the Livestock Sector

Beef accounts for about half of all meat consumed in Thailand. The majority of Thais receive about 80% of their calories from rice, a level that is regarded by nutritionists as too high and reflects an unbalanced diet. Meat consumption, on the other hand, is far too low. According to the Food and Agriculture Organization of the United Nations (FAO), the per-capita consumption of meat in Thailand in 1963 was 13.5 kg/year consisting of 2 kg of beef, 6.2 kg of pork, 3 kg of poultry, and 2.3 kg of other kinds of meat. The average Thai receives only about one-third of the minimum animal protein requirement. The demand for beef during 1970–78 rose at an average rate of 5–6%/year, whereas its production rose by 2%/year resulting in a steep rise in beef prices

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and occasional beef shortages. The wholesale price index of meat rose from an average of 7 baht/kg in 1962 to an average of 18 baht/kg in 1978 (as of 1970, 20 baht = U.S. $1.00), a 157% increase compared with 122% for the general wholesale price index.

Government attempts to regulate the price of beef have been quite ineffective. In 1980, for example, the retail price of beef was roughly 45–50 baht/kg, which is about 80% higher than the "control price" of 28–34 baht. One factor responsible for high and rising prices is the lack of a commercial beef industry that, in turn, inhibits scientific improvement of breeds and herd expansion on a large scale. The growth in buffalo and cattle production has clearly failed to keep pace with the rise in demand for beef caused by population growth and increased export demand.

Traditional livestock production is closely related to crop production and is characterized to a large extent by joint products and services. Buffalo and cattle are raised primarily for draft with meat production as a by-product at the end of their working life (at about 10–12 years). Each farm family owns a small number (1–4) of animals using low-cost production technologies depending mainly on open-access resources, agricultural residues, and family labour,[3] with no specific provision for feed. During the dry season, village animals are herded on the harvested paddy fields where they graze on rice stubble. Rice straw and grasses cut from areas inaccessible to animals are used as supplementary forage. During the wet season, when most fields are planted, the animals are grazed on communal pastures, fallow fields, and scrub forests. During the late wet season, grass is often cut and carried back for the animals to avoid crop damage.

There are relatively few large herds (10–40 animals) and these are owned by the wealthier farmers and are usually herded by hired labour. Only 5% of cattle and buffalo are commercially produced. Virtually all large-scale ranches are run by exporters, who are required by law to raise their own animals for export. The breeding stock is fed with grains, high-quality grass, legumes, and concentrated feed as well as being grazed on private pastures.

Despite rising demand,[4] the improvement and expansion of herds have been limited. The number of buffalo in the standing stock has not changed much. The average growth rate between 1961 and 1970 was 1.7% and decreased to 0.6% between 1971 and 1979, whereas the number of cattle in the standing stock was increasing at an average rate of 2.9% between 1961 and 1970 and falling at the rate of 0.9% between 1971 and 1979. Attempts to increase productivity have had only limited success partly because buffalo and cattle are not viewed by the farmers as purely commercial assets.

Although both buffalo and cattle are used mainly for draft power, profitability is a factor in their supply. Thai farmers, especially in the Northeast, ex hibited their responsiveness to economic opportunities through the rapid adoption of corn and kenaf in the 1960s and the more recent shift from kenaf to tapioca as relative prices changed. Nevertheless, their response to economic opportunity in the case of buffalo is not as immediate because of the long animal life cycle.

Retired buffalo and cattle are sold as live animals to intermediaries who transport them to slaughterhouses in the area or in Bangkok. On the average, farmers receive about 75% of the price paid by the final consumers (Hathamart 1976). The cost of transport represents more than 40% of the total marketing cost (Tables 1 and 2). A considerable reduction in marketing cost is expected to result from a shift toward more local slaughtering and refrigerated transport of carcasses. Other possibilities for reducing marketing margins are the reduction of the monopoly power of slaughterhouses and the provision of a central price information mechanism used as a basis for the introduction of grades and the signaling of market information to the farm level.

According to a study by the United Nations Development Programme and FAO (UNDP/FAO 1975), the estimated profit of raising a buffalo from birth to a weight of 550 kg was 1.98 baht/kg for male buffalo and 2.94 baht/kg for female buffalo and for cattle from birth to a weight of 350 kg was 2.3 baht/kg for male cattle and 4.3 baht/kg for female cattle. In 1981, NESDB estimated the profit of raising buffalo for 3 years to be −516 baht/head and of cattle 854 baht/head. However, it should be noted that the cash cost of raising these animals was very low indeed, only 35 baht/head (Table 3), because of the

[3]During 1960–70, the average number of buffalo per farm family was 1.49 and 1.11 for cattle. Between 1971 and 1979, the average number of buffalo per farm family was reduced to 1.40 and 1.60 for cattle. Between 1960 and 1969, the average planted land was 7.99 rai/buffalo and 5.79 rai/head of cattle (6 rai = 1 ha). These were increased to 9.24 rai/buffalo and 7.49 rai/head of cattle between 1970 and 1979. The grazing area per animal had been declining since 1966 with an average grazing area of 0.73 rai/animal with an average rate of decrease at 7.15%/year between 1966 and 1978. The average grazing area per animal was only 0.77 rai in 1978 according to the Division of Agricultural Economics, Ministry of Agriculture and Cooperatives.

[4]Consumption growth rate was 4%/year between 1965 and 1976 and was estimated to be 8.59% between 1977 and 1988. The growth of the demand for draft animals was estimated to be 2.7%/year between 1978 and 1982 according to the Division of Agricultural Economics.

Table 1. Farmgate price and Bangkok wholesale price of live animals and meat, 1962–80.

Year	Buffalo				Cattle					
	Farm price (baht/head)	Farm price index (1967 = 100)	Bangkok wholesale price index (1962 = 100)	Bangkok wholesale price of meat (baht/kg)	Farm price (baht/head)	Farm price index (1967 = 100)	Bangkok wholesale price index (1962 = 100)	Bangkok wholesale price of meat (baht/kg)	Wholesale price index of chicken	General wholesale price index
1967	1540	100.0	114	7.72	1315	100.0	125	9.07	100.0	111
1968	1648	109.4	116	7.81	1485	111.1	128	9.30	112.5	107
1969	1631	108.2	118	7.99	1527	116.4	132	9.59	112.1	108
1970	1464	97.1	121	8.20	1375	104.8	138	10.00	106.9	102
1971	1401	93.0	121	8.20	1437	109.5	138	10.00	104.5	110
1972	1614	107.1	129	8.73	1490	113.6	139	10.06	103.1	118
1973	2016	133.7	149	10.03	1833	139.7	162	11.71	121.6	146
1974	3569	238.2	229	8.51	3103	236.4	242	12.17	157.2	187
1975	3694	245.3	267	18.01	3184	242.6	313	22.72	164.9	195
1976	3799	255.3	260	17.57	3127	242.5	328	23.77	164.4	202
1977	3584	237.7	248	16.75	2860	217.8	289	20.96	174.3	213
1978	3643	241.6	250	16.89	3035	231.1	275	19.96	175.5	222
1979	4315	286.1	270	18.67	3195	243.3	297	21.54	193.3	—

Note: As of 1970, 20 baht = U.S.$1.00.

Source: Division of Agricultural Economics, "Selected economic indicators relating to agriculture" (1975 and 1979 issues). Ministry of Agriculture and Cooperatives, Bangkok.

Table 2. Farmgate and wholesale prices of live animals for slaughter by weight, Thailand, 1979.

	Farmgate price (baht/head)	Local market wholesale price (baht/head)	Bangkok market wholesale price (baht/kg)
Buffalo (kg)			
450	2982	3275	
450–550	3227	4374	10.06
550	4835	5231	
Cattle (kg)			
250	2334	2929	
250–350	3195	3928	15.57
350	4051	4990	

Note: As of 1970, 20 baht = U.S.$1.00.
Source: Division of Agricultural Economics, "Statistics of agricultural products: prices 1979," Ministry of Agriculture and Cooperatives, Bangkok.

zero cash cost of inputs like communal grazing land and family labour.

In spite of the low cost and popularity of the two-wheel tractor, the estimated demand for draft animals in 1978 was about 2×10^6/year (according to the Division of Agricultural Economics)[5] and could be increasing due to the escalation of fuel prices.[6]

The main export markets for live cattle and buffalo are Hong Kong, Malaysia, and Singapore. The markets are limited due to problems of transport and disease. Hong Kong is the main importer. More than 90% of the exports go to Hong Kong where the market share of animals from Thailand has been more than 10% but recently began declining due to competition from China, Indonesia, and Australia. In the 1960s, the average value of buffalo and cattle exports was about 82 million baht and 16 million baht/year, respectively, with a slight downward trend. In the 1970s, the average value of exports rose to 93 million baht/year for buffalo and to 66 million baht/year for cattle with a pronounced upward trend especially since 1977, according to figures from the Division of Agricultural Economics. The number of live buffalo exported declined steadily from more than 100 000 animals in 1960 to less than 20 000 animals in 1979, whereas that of cattle rose unsteadily from a few hundred animals in 1960 to almost 25 000 animals in 1979. These figures, however, do not include a considerable number of animals smuggled out of the country to Malaysia.

Explanation of the Variations in Stocks, Consumption, and Exports

From the above overview at least three facts emerge: (a) the stocks of buffalo and cattle rose slowly but steadily during the period 1961–70 and fluctuated widely, declining on the average, between 1971 and 1979; (b) the supply of buffalo and cattle for slaughter (and presumably the domestic consumption because meat exports are minimal) fluctuated as well as rose considerably during the second period; and (c) the export of live buffalo declined steadily since 1960, whereas those of cattle fluctuated considerably with a slight upward trend on the average.

In this section an attempt is made to explain these variations in the stocks through a preliminary and admittedly ad hoc specification and estimation of stock, consumption, and export equations. The relationship between the retail price of beef and the farmgate price for live animals is also examined.

The stock of live animals is postulated to depend on the farm price of live animals because it is believed that the farmers are responsive to the profitability in raising the animals, the size of the stock the preceding year, and the number of animals slaughtered, exported, and those that died due to disease. In this ad hoc specification we have also included grazing land (as the majority of animals are fed on crop residues and communal pastures), cropland as a variable accounting for the use of draft animals, and a dummy variable representing developments in this sector since 1972:[7]

$$(1) \quad SLA_t = f(FPL_t, SLA_{t-1}, SLG_t, EXL_t, DSS_t, GRN_t, CRN_t, DEV)$$

where SLA_t = stock of live animals (in '000 of head), FPL_t = farm price of live animals (in baht/head), SLG_t = number of animals slaughtered (in '000 of head), EXL_t = number of live animals exported from Thailand, DSS_t = number of animals dying due to disease, GRN_t = grazing land (in '000 of rai), CRN_t = cropland (in '000 of rai), and DEV = dummy variable, 1 assigned to the year 1972 and after and 0 assigned to the remaining years.

The retail price of beef is postulated to depend on the farm price of live animals and the dummy vari-

[5]According to Sriboonchitta (1975), the cost of using two buffalo for a 40-rai paddy land in 1974 was 3056 baht compared with 1864 baht for a diesel tractor and 2125 baht for a gasoline tractor.

[6]The price of high-speed diesel fuel in Thailand increased from 0.98 baht/L in 1971 to 1.41 baht/L in 1973, 2.33 baht/L in 1974, 2.64 baht/L in 1977, 4.88 baht/L in 1979, and 7.39 baht/L in 1980.

[7]Since 1972, efforts to develop the livestock sector through better breeds and control of disease have begun to produce results, although it must be noted that these developments have favoured cattle over buffalo.

Table 3. Cost of raising buffalo and cattle (baht/head) for a 3-year period, Thailand, 1981.

Item	Buffalo			Cattle		
	Cash	Noncash	Total	Cash	Noncash	Total
Variable cost						
Labour						
Harvesting forage	—	872	872	—	578	578
Feeding	—	74	74	—	62	62
Tending	—	677	677	—	364	364
Watering	—	85	85	—	33	33
Total labour cost	—	1708	1708	—	1037	1037
Material						
Stock	—	750	750	—	500	500
Water and energy	—	224	224	—	147	147
Equipment	30	—	30	30	—	30
Medical care	—	36	36	—	36	36
Total material cost	30	1010	1040	30	683	713
Other						
Repair	—	60	60	—	60	60
Opportunity cost of working capital	5	442	447	5	282	287
Total other cost	5	502	507	5	342	347
Total variable cost	35	3220	3255	35	2062	2097
Fixed cost						
Opportunity cost of land	—	568	568	—	329	329
Repairing cost of stable	—	120	120	—	120	120
Depreciation of stable	—	120	120	—	90	90
Opportunity cost of capital	—	12	12	—	6	6
Total fixed cost	—	820	820	—	545	545
Total cost	35	4040	4075	35	2607	2642
Farmgate price	3559	—	3559	3496	—	3496
Profit	3524	—	−516	3461	—	854

Note: As of 1970, 20 baht = U.S.$1.00.
Source: NESDB Agricultural Policy Planning 1982–86, Bangkok.

able representing developments in the livestock sector since 1972. This equation is intended to reflect the degree of competition in the livestock/beef market as it relates the retail price of beef to the farmgate price of live animals:

$$(2) \quad RPB_t = f(FPL_t, DEV)$$

where RPB_t = retail price of beef in baht/kg.

Exports of live animals are postulated to depend on the price difference between the farm price and export price of live animals, the per-capita income of the major importing countries, and the dummy variable for sectoral developments and time. Hong Kong is the major importing country especially for live buffalo. Malaysia and Singapore are also important importers:

$$(3) \quad EXL_t = f(PDF_t, PKI_{HK}, PKI_M, PKI_S, DEV, TME)$$

where PDF_t = price difference between farm price and export price of live animals (in baht/head); PKI_t = per-capita income and importing countries (in own currency) for Hong Kong, Malaysia, and Singapore; and TME = time (1968 = 1).

Domestic beef consumption is specified to be a function of the retail beef price; the retail price of substitutes, i.e., pork and chicken; the per-capita income of Thailand; and again a dummy variable for sectoral developments in the livestock sector and time:

$$(4) \quad DBC_t = f(RPB_t, RPS_{pork}, RPS_{chicken}, PKI, DEV, TME)$$

where DBC_t = apparent per-capita domestic disappearance of beef in kilograms, a measure of per-capita beef consumption.

The empirical results obtained through the econometric estimation of these relationships using an-

nual data for 1968–78 are reported in Table 4. The stock of buffalo was found to be negatively related to the preceding year's stock, to the cropland area, and to sectoral development since 1972 and positively related to time. All these factors were statistically significant and could explain up to 80% of the stock variation. The negative effect of lagged stock may be due either to a cyclical behaviour of livestock farmers due perhaps to the indivisibility of the basic animal unit or to a variable weaning rate in the sense of a strong class of weaners followed by a weak one. (Without a detailed study of the microaspects of livestock it is not possible to identify the exact reason.) The negative relationship between cropland on buffalo stock may be attributed to the increasing use of mechanical power in the irrigated paddy and double cropping areas and to expansion in upland areas where cattle are more commonly used, although, as we will see below, the stock of cattle is also negatively related to total cropland. Improved utilization of existing stocks through increased use of dual-purpose animals and the development of a rental market for draft power may have also contributed to the negative relationship between cropland area and the buffalo stock. Although the latter showed a mildly increasing trend over time, development since 1972 has favoured cattle over buffalo resulting in a negative effect on the buffalo stock and a positive one on cattle. It is also important to note that variations in the farmgate price for live buffalo had no statistical significance in explaining variations in buffalo stocks.

Seventy-two percent of the variation in the stocks of cattle could be explained by the farmgate price of live cattle, last year's stock, death due to diseases, grazing area, cropland area, and sectoral develop-

Table 4. Domestic and export demand and stocks of live animals, regression equation and parameter estimates.

Stocks of live animals

Buffalo

$SLA_t = 10194.00 - 0.527\ SLA_{t-1} - 0.025\ CRN_t - 460.893\ DEV + 192.73\ TME$
$(-2.309)\quad (-2.849)\quad (-4.025)\quad (6.183)$
$R^2 = 0.929\quad R^{-2} = 0.802\quad F = 19.711\quad d = 3.222$

Cattle

$SLA_t = 7361.867 + 0.571\ FPL_t + 1.287\ SLA_{t-1} - 0.523\ DSS_t - 0.152\ GRN_t - 0.092\ CRN_t + 598.941\ DEV$
$(2.233)\quad (2.065)\quad (-2.182)\quad (-3.127)\quad (-2.792)\quad (1.817)$
$R^2 = 0.888\quad R^{-2} = 0.721\quad F = 5.300\quad d = 3.497$

Retail beef price

Buffalo

$RPB_t = 3.990 + 0.004\ FPL_t$
(19.632)
$R^2 = 0.977\quad R^{-2} = 0.975\quad F = 385.428\quad d = 2.033$

Cattle

$RPB_t = 3.903 + 0.006\ FPL_t$
(10.536)
$R^2 = 0.925\quad R^{-2} = 0.917\quad F = 111.02\quad d = 1.403$

Export of live animals

Buffalo

$EXL_t = 17626.27 - 6.602\ PDF_t + 11.753\ PKI_{HK} + 4.931\ PKI_M - 31.647\ PKI_S$
$(-2.514)\quad (2.340)\quad (1.821)\quad (-2.353)$
$R^2 = 0.786\quad R^{-2} = 0.643\quad F = 5.497\quad d = 2.395$

Cattle

$EXL_t = -81935.47 - 3.427\ PDF_t + 17.196\ PKI_{HK} + 4.879\ PKI_M + 10222.93\ DEV - 8957.341\ TME$
$(1.147)\quad (2.352)\quad (1.609)\quad (-2.563)$
$R^2 = 0.829\quad R^{-2} = 0.658\quad F = 4.849\quad d = 2.115$

Domestic beef consumption

Buffalo

$DBC_t = 0.690 - 0.048\ RPB_t + 0.053\ RPS_{pork} - 0.051\ RPS_{chicken}$
$(-3.711)\quad (4.025)\quad (-2.085)$
$R^2 = 0.729\quad R^{-2} = 0.618\quad F = 6.280\quad d = 2.999$

Cattle

$DBC_t = 0.736 - 0.072\ RPB_t + 0.039\ RPS_{pork} + 0.0001\ PKI$
$(-3.593)\quad (2.084)\quad (1.970)$
$R^2 = 0.692\quad R^{-2} = 0.560\quad F = 5.247\quad d = 2.152$

ments. The cattle raisers were found to be only moderately responsive to changes in the farmgate prices of live animals. The elasticity of stock holding with respect to the farmgate price for live animals was estimated to be 0.294 (Table 5), suggesting that a 10% increase in the price will lead to almost a 3% increase in the stock. Unlike the case of buffalo, a positive relationship was found between current and lagged stocks of cattle, due presumably to the more "robust" weaning rates of cattle. As expected, deaths due to disease contributed to a reduction in stock, whereas the increase in grazing area led, contrary to expectations, to a decrease in cattle stocks. However, this result is not surprising considering the overgrazed state of communal pastures and the expansion into marginal lands and scrub forests of limited grazing value. Price (1972) has estimated that forage requirements are 10 rai of residue with straw per animal, 17–23 rai of fallow land per animal, or 40 rai of forest per animal. Unfortunately, it was not possible to standardize the grazing land and express it in effective grazing units. In a way analogous to buffalo the increase in cropland area had a negative effect on the cattle stock. The data are for 1968–78 when there was considerable mechanization despite rising fuel prices. The negative effect on stocks of an increase in cropland could also be explained by the extension of cropland into communal grazing lands. On the other hand, the development efforts in the livestock sector since 1972 appear to have had a significant effect in increasing cattle stocks.

The retail prices of beef were found to be positively related to the farmgate price of live animals.

Table 5. Elasticities of buffalo and cattle.

	Buffalo	Cattle
Inventory of live animals (ILA_t)		
ILA_{t-i}	−0.523	1.280
CRN_t	−0.423	−2.072
FPL_t	—	0.294
DSS_t	—	−0.058
GRN_t	—	−0.228
Retail price of beef (RPB_t)		
FPL_t	0.708	0.784
Export of live animals (EXL_t)		
PDF_t	−0.474	−0.080
PKI_{HK}	2.603	4.703
PKI_M	3.450	4.216
PKI_S	−5.446	—
Domestic beef consumption (DBC_t)		
RPB_t	−1.927	−1.333
RPS_{pork}	3.931	1.118
$RPS_{chicken}$	−2.922	—
PKI_t	—	0.523

Source: Computed from Table 4.

The variation in farmgate price could explain 95% of the variation in meat retail price for buffalo and 93% for cattle. The elasticities of the beef retail price with respect to the farmgate price of live animals were 0.708 for buffalo and 0.784 for cattle. These indicate a close connection between the farmgate prices of live animals and beef retail prices and do not support the hypothesis of monopolistic practices by traders.

Sixty-four percent of the variation in the export of live buffalo could be explained by the price variable, time, and the per-capita income of the major importing countries, Hong Kong, Malaysia, and Singapore. The large portion of the variation left unexplained is most likely due to quotas and other quantitative controls frequently imposed on exports of live animals following an outbreak of disease. The increase in per-capita income in Hong Kong and Malaysia could increase the export of live animals (the elasticities were 2.603 and 3.450, respectively). In the case of Singapore, as the per-capita income increased the import of buffalo from Thailand decreased because of the "inferior goods" nature of buffalo meat in a high-income country. About 66% of the variation in the export of live cattle could be explained by the price difference; the per-capita income of the two main importers, Hong Kong and Malaysia; the livestock sector developments; and a time trend. Exports of live animals to Hong Kong and Malaysia were found to be elastic with elasticities of 4.7 and 4.2, respectively (Table 5), indicating considerable potential for expanding cattle exports to these countries once the animal diseases have been controlled and other supply constraints relaxed. Development of the sector since 1972 has had a favourable effect on the export of live cattle because of the improvement in animal quality.

More than 60% of the variation in the per-capita domestic consumption of buffalo meat could be explained by the retail price of beef and the retail price of related meats, namely pork and chicken (Table 4). The price elasticity of demand for buffalo beef was found to be about 2.0, implying that a 1% reduction in the price of beef would lead to a 2% increase in its per-capita consumption. Pork and buffalo meat were found to be substitutes with a cross price elasticity of 3.9, whereas beef and chicken were found to be complementary with a cross price elasticity of −2.9 (Table 5).

Only 55% of the variation in per-capita consumption of cattle meat could be explained by the beef retail price, the retail price of substitutes (pork in this case), and per-capita income. A 1% decrease in retail beef price could lead to a 1.3% increase in cattle meat consumption, namely a 1 baht decrease in beef price could lead to an increase in per-capita beef con-

sumption of 72 g. Pork and cattle meat were found to be substitutes with a cross elasticity of 1.1; a 1 baht increase in the price of pork would lead to a 39 g increase in beef consumption. Per-capita beef consumption was relatively inelastic with respect to income; an increase in per-capita income of 10% would increase per-capita consumption of cattle beef by only 8% (Table 5).

Conclusions

A reduction in the price of beef or an increase in the price of pork would lead to a substantial increase in the per-capita consumption of both buffalo and cattle meat, whereas an increase in per-capita income would have a significant effect only in the case of cattle meat consumption. The retail price of meat paid by the consumers could be lowered by lowering the farmgate price of live animals, but this would lead to a reduction in the cattle stocks resulting in higher meat prices in future. In contrast, increases in the farmgate price for live buffalo are not likely to affect significantly buffalo stocks that are held primarily for draft power.

The generally low and variable weaning rate of local buffalo breeds and the bias of breed improvement programs have had adverse effects on the stock of buffalo that, nevertheless, has been increasing slowly but steadily over time due to the buffalo's primary function as a draft animal. However, the use of buffalo for draft, often until the age of 12–15, results in poor beef quality. Breed improvements and disease control have helped maintain stocks at current levels but more assistance is needed; buffalo in particular call for more attention than they have received in the past. In this respect, it is commendable that the pioneer Cooperative Buffalo Production Research Project between the Department of Livestock Development and Kasetsart University, which has been operating since 1975, is being expanded into a National Buffalo Research and Development Center to organize and coordinate buffalo research and development projects.

The negative relationship found between the cropland area and the stocks of both buffalo and cattle warrants further investigation as does the underlying relationship between the expansion of crop cultivation into prime grazing land and the consequent expansion of grazing into marginal lands and scrub forests. One of the major constraints on livestock development is undoubtedly the overgrazed state of communal pastures and the lack of supplemental feed during the dry season when pastures are poor.

On the export demand side, there appears to be considerable opportunity for Thailand to increase its foreign exchange earnings by expanding its export of live animals to neighbouring countries whose income elasticity of demand is high and whose incomes are growing rapidly. However, much of this potential cannot be realized without effective disease control.

As to domestic trade, our study has offered little support to the frequent assertion that it is monopolistically controlled. Although marketing margins appear to be in the range of 20–30%, we found no evidence to support the claim that price signals are not transmitted effectively from the consumer to the producer. The relatively large marketing margins are more likely the result of inefficiencies caused by the cumbersome regulations on animal transport and slaughter rather than the lack of competition (see Nipon, this volume).

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Livestock Policy Choices: the Philippine Experience

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Abstract. Growth of the livestock industry in the Philippines depends upon several factors, the most important of which is the price and supply of feed and feed substitutes because feed represents 70% of the cost of producing livestock. Moreover, there is insufficient feed supply so that imports of corn, soybean, and other protein meals have been necessary. Government's role has been to induce farmers to produce more corn and soybeans, to give leasehold contracts for the cattle ranchers, to enable farmers to take advantage of the loan programs, to support technical research on feeds and livestock as well as market research, and to engage directly in the marketing of livestock. Underlying factors, like consumer income, population growth, and price trends in other commodities must also be considered in making policy decisions because they all have an important role in the livestock industry.

Résumé. La croissance de la production de bétail aux Philippines dépend de plusieurs facteurs, le plus important étant le coût et l'approvisionnement en fourrage ou substituts alimentaires, la nourriture représentant 70 p. 100 du prix de revient. En fait, la production nationale d'aliments du bétail est insuffisante, de sorte qu'il faut importer du maïs, du soja et d'autres farines protéiques. Le gouvernement a joué un grand rôle en encourageant les fermiers à produire plus de maïs et de soja, en accordant de longs baux aux exploitants de ranchs, en incitant les fermiers à profiter des programmes de prêts, en finançant des recherches techniques sur les nourritures animales, le bétail et les marchés, et enfin en s'engageant directement dans la commercialisation du bétail. D'autres facteurs moins apparents doivent être pris en compte par les décisionnaires, car ils ont une incidence sur l'économie de l'élevage, ce sont : le revenu du consommateur, la croissance démographique, les tendances des prix des autres marchandises, etc.

The commercial production of poultry and hogs has dominated growth of the livestock industry during the 1970s. Efficient, technically advanced, large-scale producers of hogs, poultry, and eggs now provide a large share of total supply and most of the supplies for urban markets. Large efficient hatcheries now supply about a third of the broiler and egg-producing chicks. Commercial production by large hog producers, defined as those with more than 100 sows, accounts for about 20% of total hog production. Output of the commercial livestock sector moves mainly to metro Manila and other large urban centres, where high-income consumers buy most of the preferred cuts at controlled prices.

Growth of the commercial livestock industry is constrained by limited domestic supplies and high costs for feed concentrates. These include mainly by-product feeds from the milling of rice, corn, and wheat, as well as substantial imports of corn, soybean meal, and other feedstuffs. Such imports draw on the relatively tight supplies of foreign exchange.

Although demand for meats is strong and expanding, the market is considered rather weak at current ceiling prices for meats. Incomes of most workers are not high enough to permit them to buy much meat and poultry. At the same time, the use of meats is very responsive to price. As a result, the market could be greatly expanded as larger supplies and lower costs for feeds lead to larger output, lower production costs, and lower prices for livestock products.

In 1981, 16% of the domestic beef consumption was imported as was about 98% of milk and milk products. Although there is very little trade (imports or exports) in pork and poultry, in recent years about 8–10% of domestic use of livestock and livestock products comes from imports — mainly the beef and milk products. Output of the beef industry has changed little in recent years. Moreover, potential for expansion does not look promising unless the

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country can correct management problems involving efficiency in breeding stocks, disease and parasite control, and institutional arrangements that limit effective use of pasture.

Suggested Policy Issues

Livestock issues are closely related to policies that affect the production of corn and other feedstuffs, trade restricting practices, and price controls.

- Self-sufficiency or import? Policymakers would prefer self-sufficiency in both feed and livestock products. This preference certainly looks logical in view of available land, production technology, and financing for feed, pork, and poultry products.
- Will the domestic market absorb large increases in output of livestock products? Lower prices for livestock products would greatly expand the domestic market because of the high price elasticities of demand for most livestock products.
- Economic development issues oriented toward expanded employment, rising incomes, improved income distribution, and perhaps special nutrition programs would give a strong boost to demand for all livestock products.
- Unlike pork, poultry, and eggs, beef and milk issues revolve around production problems. Many of these are technical control problems of disease and parasites and sources of pure breeding lines involved in developing and maintaining highly productive animals. Current programs relate mainly to supervised credit schemes (loan programs), livestock dispersal programs, and research and development work in livestock breeding and disease and parasite control. The Bureau of Animal Industry (BAI) now has two livestock loan and dispersal programs under way and is going to expand to six by March 1982. It also has 12 stock breeding farms and research stations within those farms conducting research on pasture (establishment, propagation, etc.), disease control (ectoparasites, endoparasites, viruses, bacteria, etc.), and animal husbandry research (management practices, breeding, etc.). An associated set of issues revolves about the development of roughage production and improved pastures. In addition to technical problems in producing more and better roughage and control of parasites, are issues in public land policy that restrict leasing and the use of range and natural pastures.

A recently initiated program has set up a national dairy corporation that is launching large-scale production on a farm estate in Bukidnon. This program will face many production constraints. A solution to these problems will be necessary if an efficient, productive beef and dairy program is to result. Marketing problems will emerge as production expands, but these issues are farther along in development of the cattle industry.

- Small farmers raise goats mainly in small backyard lots. Most of the commercial farms specialize in breeding goats and usually have more than a hundred head each. Pasture is less of a problem than it is for cattle because goats thrive on any kind of roughage and need only a limited amount of grazing land. Government's thrust is to have this program operate on the *barangay* level and establish a supervised credit program. However, more research has to be done on breeding and especially on disease and parasite control, because goats are more disease-prone than cattle.
- Policies on fisheries production and trade policy are tied to policies for livestock. This tie relates mainly to demand as fish products now provide more than half the animal protein in the average Filipino's diet. Meat and fish compete actively in the market, but there appears to be ample market for both to expand, particularly through the use of cost-reducing technologies.

Livestock Product Output and Use

Livestock products make up only 4–5% of total food produced. Fish accounts for about the same percentage, whereas more than 90% of all food comes from domestic crop production. However, in terms of value per kilogram or tonne, livestock accounted in recent years for 17–18% of total food output, fish a slightly smaller share, and food crops more than two-thirds.

Livestock products, including substantial imports of meat and milk, account for nearly a fourth of total value of food consumption and fish for slightly less than 20%. Consumption of crop products accounts for less than 60% of the constant peso value of food production. A large share of such food crops as coconut, sugar, pineapple, and even banana are exported. Hence, the share of crops in domestic food consumption is less than their relative share of total food output.

Production of livestock and poultry products in 1981 was around 25% above lows early in the 1970s. The trend of output was slightly downward in the first half of the decade. The upward growth since the mid-70s reflects the rapid expansion of commercial production of hogs and poultry even though backyard production apparently continued to decline. In recent years, high grain-consuming livestock represented nearly a fifth of total production, nearly double the ratio earlier in the decade. Production of

beef has changed little in recent years and beef imports supply about 15–17% of the domestic market. Also very little milk is produced so that about 98% of milk products are imported. Per capita use of livestock products apparently declined in the 1970s. However, the expansion in commercial livestock production and imports has resulted in slight consumption increases in recent years. Fish continues to be a main source of protein in the diet and the consumption pattern has changed little over the decade.

In recent years, the Philippine livestock-feed industry has reflected the pressure of an expanding domestic market limited by inadequate supplies and high costs of feed concentrates. Relatively stable corn production in recent years has been supplemented by larger imports of yellow corn and soybean meal. But with further expansion in output by large commercial producers of hogs and poultry, who use most of the grain concentrates, feed supplies continued to be limited and costly. Even the large, well-financed and well-connected commercial producers, found it difficult to get sufficient feed even at relatively high prices. The smaller hog and poultry producers in particular were caught between rising costs for feed and ceiling prices imposed on their products.

Pork Production

In 1980, limited supplies and high costs of feed accounted for a significant reduction in hog breeding herds. In January of 1981 the total number of hogs was down slightly more than 7% from a year earlier. This decline occurred mainly among the smaller producers (5–50 sows) rather than among the very large producers or the very small backyard producers.

Although the larger commercial producers were affected, they were able to secure available high-cost feed more easily. Moreover, the large efficient producer experienced margins wide enough to continue to operate under product ceiling prices and rising feed costs. The strong upward trend in commercial breeding herds was slowed only temporarily in 1980. The large producer was in a position to benefit from the overall reduction in hog supplies in 1981 and the upward pressure on prices that apparently is extending into 1982.

Broiler and Egg Production

Broiler production initially declined sharply early in 1980 due to limited high-cost feed. Although output recovered rather quickly, broiler production continued to drop through to mid-1981. Broiler prices averaged 15–20% above levels recorded a year earlier. Higher product prices and more feed led to a sharp recovery in broiler production in the last quarter of 1981.

Commercial broiler-breeder herds, which apparently were not so severely affected as egg-laying flocks, were supplemented by imports of breeding stock. By the end of 1981, broiler production increased moderately from levels recorded a year earlier. With higher ceilings and market prices, 15–20% above the first half of 1980, the market was glutted with broilers. This resulted in a build-up in cold storage holdings and renewed requests for export permits.

Beef and Milk Production

Total numbers have changed little in recent years, although available data suggest a leveling in the downward trend experienced in earlier years. Cattle and dairy production programs have recently begun, but production is still constrained by management problems, widespread disease and parasite infestations, high mortality rates, and breeding problems. Public land policies also limit the effective use of public range and pasture lands.

Production Potential

Livestock output potential for the Philippines is promising for hogs and poultry mainly because of the relatively large land base and available technology, which offer good prospects for increased production of corn and other feeds. A recent corn production program, based on present technology used in high-production areas, also promises yield gains large enough to reduce the cost of feeds.

Another major reason for predicting an increase in the production of hogs and poultry is indicated by the strong domestic market potential. Use of pork and poultry is highly responsive to changes in price and consumer income, and the market is currently limited because of low income and high meat prices. But the high price elasticity of demand, with significant gains in feed production and reduced feed costs as well as rising prices for fish, will greatly expand the domestic market for pork and poultry. Moreover, low livestock production costs will enhance the potential for exports of these meats to near-by Asian markets. Ongoing research has been conducted on suitable pasture varieties for cattle, carabao, and goats. Larger feed concentrate supplies will permit improved nutrition for the small hog and poultry producer. Breeding and disease control programs are designed to expand the output of hogs, poultry, and cattle.

Supply Response Analyses

Except for recent years, the data base is considered too weak to justify attempts at sophisticated supply response analyses. Monthly and quarterly data for recent years reveal expected relationships for broilers and hogs (Figs 1 and 2).

Monthly Broiler Hatch

$$BH_t = 14190.41 + 354.93\ PB_{t-6} - 266.77\ PC_{t-2}$$

t-values (3.11) (11.47)
elasticity [0.55] [−0.20]

$$-575.79\ D_1 - 841.70\ D_2 - 695.55\ D_3$$

(4.44) (6.88) (5.67)
[−0.07] [−0.10] [−0.09]

$R^2 = 0.86$
DW = 1.19

Quarterly Hog Fatteners

$$FH_t = 426 + 1795\ PH_{t-6} - 3288\ PC_{t-6} + 251\ D_1$$

t-values (2.65) (1.60) (2.40)
eleasticity [2.54] [−0.82] [0.08]

$$-227.1\ D_2 + 82.8\ D_3$$

(1.80) (0.69)
[−0.04] [0.02]

$R^2 = 0.81$
DW = 1.73

where BH_t = broiler chick hatch ('000 heads) in month t; PB_{t-6} = wholesale chicken price (P/kg) lagged 6 months; PC_{t-2} = wholesale price yellow corn (in pesos/50-kg bag) lagged 2 months; D_1, D_2, D_3 = seasonal dummy shift variables, 1st, 2nd, and 3rd quarter dummy; FH_t = inventory of hog fatteners, month t (in thousand head); PH_{t-6} = wholesale hog prices lagged 6 months (P/kg); and PC_{t-6} = wholesale price yellow corn lagged 6 months. The data used for the broiler hatch equation are the monthly hatch statistics and broiler and corn prices from 1976–80 with their corresponding time lags (Fig. 3). The quarterly hog fattener equation used quarterly hog fattener statistics from 1977–80 and hog and corn prices with their corresponding time lags.

Demand for Livestock Products

Demand relationships for recent hog cycles suggest that the information for the past 10 years is fairly accurate despite the uncertainty of the data (Fig. 4). There have been a few livestock surveys in the past 5 years and some consumption surveys conducted in the early 1970s that provide at best only rough estimates for cattle, carabao, hogs, and poultry.

Livestock products are a preferred food in the Filipino's diet. But consumption per person is very low, and output is small because of high production costs and relatively low purchasing power for most consumers (Table 1). With rising consumer incomes, the availability of low-cost meat would greatly expand the domestic market. The increased domestic demand may make it difficult to export corn and other feeds even with substantial gains in feed production. Moreover, the increased low-cost meat and poultry production may be exported to foreign markets, thereby increasing overall demand for meat even more.

Demand relationships are based mainly on food consumption surveys conducted during the 1970s. Simulations of demand relationships are also tested against previous estimates for demand-related data. Demand appraisals were more realistic when based on urban (largely commercial) and rural (largely backyard) relationships. Table 2 lists the relationships for meat, poultry, and fish.

Demand analyses for corn and feed show logical econometric relationships based on 1970–80 data. Demand for corn (DC, in thousand tonnes), as might

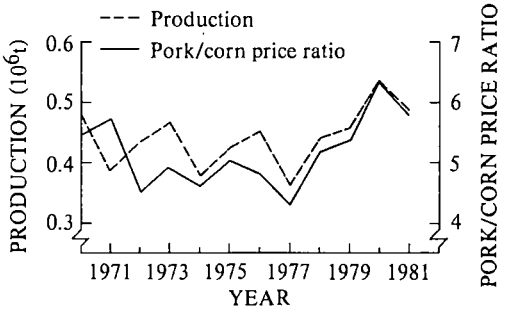

Fig. 1. Pork production compared to pork/corn price ratio, lagged 1 year (e.g., present production compared to pork/corn price ratio a year earlier).

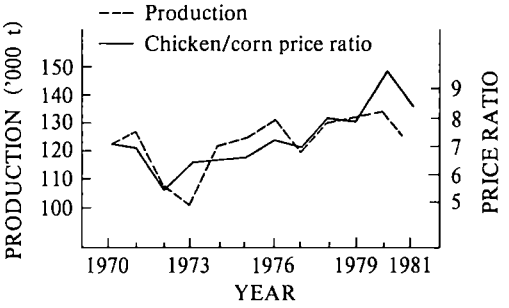

Fig. 2. Chicken production compared to chicken/corn price ratio, lagged 1 year (e.g., present production compared to chicken/corn price ratio a year earlier).

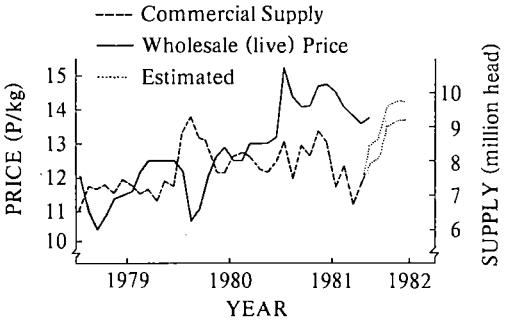

Fig. 3. Commercial broiler supplies and prices, metro Manila. (Broiler supplies are based on broiler hatch and cockerel hatch less chicks destroyed 3 months earlier.) Source: Ministry of Agriculture.

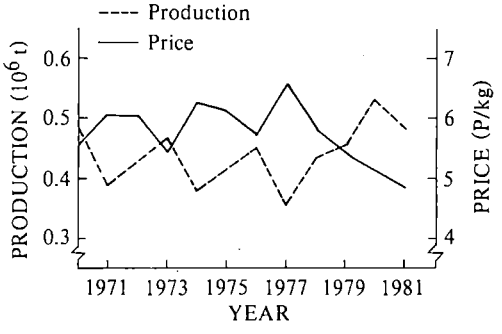

Fig. 4. Pork demand relationship.

be expected, is closely related to animal units (AU) to be fed, the price of grain-consuming livestock (PL, in pesos/kilogram) and the cost of corn (PC, in pesos/kilogram):

$$DC = 131.1 + 0.0035\,AU + 117.3\,PL - 653.6\,PC$$

t-statistic	(5.42)	(1.15)	(2.55)
elasticity	[0.80]	[0.54]	[−0.50]

$R^2 = 0.98$
DW = 2.17

The demand functions suggest a very elastic price relationship for meat and poultry with large, cross-price elasticities between competing meats (Table 2). Income elasticity of demand is also high especially in the higher income urban areas.

Policies and Potential

The Philippines has great potential for increased production and use of livestock products. It has the necessary land resources, technological capabilities, financial resources, and trained manpower. Hopefully, government policy will be initiated to stimulate economic forces that will provide the incentives and conditions to encourage output of feed and livestock products. The above assessment suggests that the future of the Philippine livestock industry will depend on: (a) an increase in the production of corn and other feeds, mainly through cost-reducing technology for expanded hog and poultry production at lower cost to the consumer; (b) a pricing system that permits the feed and livestock product markets to respond to underlying economic forces through market prices that give clear signals to the producer and the consumer; (c) an increase in backyard production of livestock through better animal nutrition, effective disease and parasite control, improved breeding, and the maintenance of improved genetic blood lines; (d) an improvement in beef and dairy production efficiency through improved breeding, control of disease and parasites, the development of improved roughage and pasture, and efficient use of public range and pasture lands; and (e) national policies to expand employment and accelerate the increase in consumer buying power.

Policy Changes and Near-Term Implications for Livestock

Depressed farm incomes, tightening supplies of corn and other feed, large feed imports, and upward pressures on grain and livestock product prices have prompted attempts to raise corn and feed production. A promising set of programs is being directed mainly toward the high-yielding, corn-producing areas. Projections suggest an output level that will almost double corn production to about 6×10^6 t within 5–6 years. The program includes price supports, subsidies for improved seed, credit, and related industry programs designed to expand production of corn and hybrid seed supplies. *Maisagana* programs will be directed mainly at the high-yielding corn areas of Mindanao and the Cagayan Valley. An effective corn program in these areas would push yields to around 4 t/ha compared with national average yields of about 1 t/ha. Generally improved earnings prospects and increased planting and higher yields would nearly double corn production in 5 years. Increased yields and lower costs per tonne, in addition to stimulating domestic feed use would permit a much slower rise in livestock product prices, or even reduce prices. Philippine corn exports would also become more competitive in world markets if production programs are effective.

Breeding work and production programs for soybeans as well as increased use of cassava and other feed products, in addition to corn, will increase feed

Table 1. Per-capita consumption (kg) of livestock products.

	Chicken	Pork	Beef	Dairy	Eggs
1970	3.4	14.9	3.2	3.1	3.0
1971	2.4	11.7	5.4	2.9	3.0
1972	2.8	12.9	5.9	2.4	3.0
1973	2.5	13.4	4.7	1.9	3.0
1974	3.0	10.6	3.7	2.2	3.0
1975	3.0	11.5	3.7	1.7	3.0
1976	3.0	12.1	3.7	2.3	3.0
1977	2.7	9.3	3.5	2.7	2.4
1978	2.9	11.0	3.6	2.2	3.3
1979	2.8	12.0	3.7	2.8	3.5
1980	3.0	13.0	3.7	2.9	3.8
1981	3.1	10.0	3.6	2.9	3.7
1982[a]	3.2	11.0	3.8	2.9	3.9
1987[b]					
Alternative I	3.3	14.0	3.9	3.0	4.4
Alternative II	3.7	15.0	4.0	3.1	4.5

[a]Estimated.
[b]Projected.
Source: Ministry of Agriculture, Philippines.

Table 2. Livestock product demand characteristics.

	Direct-price elasticity	Cross-price elasticity				Income elasticity
		Chicken	Pork	Fish	Other	
Chicken						
Urban	−1.30	—	0.30	0.40	—	1.00
Rural	−1.00	—	0.30	0.30	—	0.40
Eggs	−0.70	—	—	—	—	0.70
Pork						
Urban	−2.00	0.40	—	0.70	—	1.00
Rural	−1.50	0.40	—	0.70	—	0.40
Beef	−1.30	0.30	0.50	0.20	—	0.80
Fish	−0.85	0.36	—	—	0.74[a]	0.64

[a]Average price of pork and beef.
Source: Ministry of Agriculture, Philippines.

supplies and potential for livestock production. Larger supplies of various low-cost feeds will step up livestock production, slow the rapid rise in prices, and will also encourage better animal nutrition among the smaller commercial and backyard producers of livestock products. These conditions would have an almost immediate impact on production of poultry and hogs.

In addition to the above programs for feed and livestock, consumer buying power is expected to grow by about 3.3%/year between 1983 and 1987. This trend would reflect projected growth in real output of the economy (GNP) of around 6%/year because population growth is projected to remain at about 2.5%/year. Projections for livestock products and feed for the planning period are summarized in Table 3. Alternative I largely reflects a continuation of current programs and policies relating to the feed and livestock sector. Alternative II reflects optimistic prospects for the new feed and livestock products outlined above.

Under alternative II, nominal prices for hogs are projected to rise to P9.50 by 1987 from P8.62 in 1981 (as of 1982, P8.40 = U.S.$1.00), but decline in real terms (price deflated) by about 40% over the period. Nominal prices for chicken, based on low-cost feed, are projected to rise from P17.51 in 1981 to P18.10 by 1987. Price projections reflect a

Table 3. Livestock product output, trends, and projections.

Item	1977 Total ('000 t)	1977 Growth 1973–77 (%)	1978 ('000 t)	1980 ('000 t)	Estimated 1981 Total ('000 t)	Estimated 1981 Growth 1978–81 (%)	Projected 1982 ('000 t)	Projected 1987 Alternative I Total ('000 t)	Projected 1987 Alternative I Growth 1982–87 (%)	Projected 1987 Alternative II Total ('000 t)	Projected 1987 Alternative II Growth 1982–87 (%)
Livestock (index) 1978 = 100	93.0	−0.4	100.0	101.0	100.2	0.1	102.7	131.4	5.0	144.5	7.0
Hogs	603	−0.2	664	704	669	0.3	690	903	5.5	1006	7.8
Cattle	118	−0.7	117	119	121	1.1	122	154	4.8	158	5.4
Carabao	108	−1.9	109	76	101	−2.3	101	112	2.2	116	2.8
Goats	5	−6.9	6	6	7	1.0	7	8	2.6	8	2.6
Poultry and eggs (index) 1978 = 100	87.5	3.0	100.0	115.3	119.9	6.2	128.7	154.6	3.1	165.4	5.2
Chicken	192	5.7	188	209	222	5.8	236	269	2.6	304	5.2
Ducks, geese, etc.	7	4.3	9	10	11	6.1	12	15	4.6	20	10.8
Eggs	115	−1.1	166	199	202	6.8	219	277	4.8	281	5.1
Milk	20	12.0	17	18	19	4.2	19	22	3.0	30	9.6
Total livestock products	1167	0.5	1276	1341	1352	2.0	1406	1760	4.6	1923	6.5
Fish	1509	5.8	1580	1672	1689	2.2	1742	2146	4.3	2280	5.5
Corn	2843	11.6	3154	3185	3335	1.9	3392	4250	4.6	5900	11.7
Total food crops	23235	7.8	23328	23603	24593	1.8	25577	29069	2.6	32626	5.0
Food Crops (index) 1978 = 100	99.6	6.8	100.0	99.7	104.9	1.6	110.3	124.5	2.4	139.4	4.8
Per-capita income after tax (1972 prices pesos)	1356	2.9	1303	1363	1373	1.7	1417	1664	3.3	1664	3.3
Population, 1 July	44550	2.7	45724	48130	49362	2.6	50611	57094	2.5	57094	2.5
General price level CPI (Metro-Manila)	188.6	13.4	202.9	284.1	320.0	26.3	358.0	576.0	10.0	576.0	10.0

Note: Under alternative I, the assumption is that corn production would continue building up consistently, although slightly as it is now, without the introduction of the new corn program. Prices for livestock would assume no significant change in real prices for livestock from this year to the next 5 years (prices would go up in line with the general price level). Under alternative II, the assumption is that the present corn program is successful, pushing yields to 4 t/ha from 1 t/ha and that prices of livestock would decrease relative to general price levels because of the contribution of lower corn prices. The following assumptions are common to both alternatives: incomes would increase by 3.3%/year in the next 5 years, population would increase by 2.5%/year, and the general price level by 10%. These assumptions were made on the assumptions of NEDA, the government's economic planning body.

Source: Ministry of Agriculture and NEDA, Philippines.

rough balance between supply and demand in the domestic economy; no exports are assumed.

A successful production program for corn and feed would greatly expand the production and domestic use of livestock products in the future. Most of the expansion will reflect the continued rapid growth in poultry production and an accelerated rise in hog production. Smaller changes are expected for cattle and milk. The success of these programs will depend mainly on finding solutions to the production constraints noted in this paper.

Acknowledgment

Deep appreciation is given Dr Rex Daly, Senior Policy Analyst; Sallie Bondad, Angelita Mariano, and the rest of the Policy Analysis Staff of the Philippine Ministry of Agriculture; and to my husband Conrado Velasco, for his invaluable assistance in the preparation of this paper.

Discussion Summary

Lovell S. Jarvis

Papers were presented on livestock development policy in four different countries: Indonesia, Korea, Thailand, and the Philippines, and these were followed by a lengthy panel discussion. Policymakers in the countries mentioned were faced with somewhat different problems.

In Indonesia, the government has placed its primary emphasis on increasing agricultural output, particularly rice, through the BIMAS program. Livestock (cattle and buffalo) are used primarily for draft and manure, as intermediate goods in agriculture. The measured contribution of large livestock to GNP is small. Policymakers note that the density of livestock and human populations in different regions are highly positively correlated and fear that on Indonesia's small farms, cattle and people may be competitive in the demand for land. It was pointed out in the discussion, however, that use of livestock for agricultural production implies that these animals are complementary to the human population. Indeed, the paper presented also noted that government policymakers are concerned that the cattle and buffalo herds on Java have been stagnant during the last decade, and the government fears that there is a growing shortage of draft animals for agricultural work. Because real beef prices have been rising secularly, the government has attributed the stagnant herd to a competitive beef demand; that is, the government believes that rising beef prices are causing small producers to slaughter their animals. This behaviour was explained by several factors: irrationality of small producers, risk averse behaviour (fear of losing an expensive asset once its price had risen), and a fear that the beef price would again decline. Because the government believes that a smaller herd of cattle and buffalo would imply the availability of less draft services, with reduced agricultural output and employment (especially for small farmers), it has imposed a number of regulations to impede slaughter, e.g., male and female animals are not allowed to be slaughtered so long as they are capable of being used for draft power or for breeding, i.e., until they have reached old age or have otherwise demonstrated that they are infirm or infertile. The government is also providing credit for purchase of cattle and buffalo and is importing large numbers of animals from Australia to increase the national herd. It is also attempting to restrain the increase in the domestic price of beef.

In Thailand, government policymakers are also concerned with a stagnant or declining cattle and buffalo herd, and, again, rising beef demand is frequently identified as a major cause of the stagnation. Domestic beef demand has been rising rapidly with rising per-capita income and population, and export demand (some illegally undertaken) is also strong. The decrease in buffalo and cow stocks is a particular concern because of rapidly rising fuel prices.

Expansion of the livestock industry has been based on the use of farm wastes and by-products, on communal pastures, and on low-cost fish meal. These feed stuffs are now in short and inelastic supply, apparently placing a constraint on bovine de-

velopment. Greater emphasis has, therefore, been placed on swine and poultry development that can better utilize concentrate feeds, like cassava, which Thailand has produced in abundance in recent years. The government would nonetheless like to stimulate greater bovine production as well, although here it has demonstrated conflicting policies, both encouraging and discouraging greater output.

The government has introduced many regulations on the livestock sector, limiting the initiatives of the private sector and distorting the market, and yet has little effective control over the industry because many different government departments and ministries intervene without effective coordination, and because many illegal activities have developed to evade government regulations.

Among the most important problems faced by the livestock industry are the unhygienic conditions of official slaughterhouses and the amount of illegal slaughter (70% of the total), which make disease and meat quality control impossible. Both disease and hygiene are important barriers to the export of Thai beef products. Exports are further constrained by government barriers, both official and unofficial. Nearly every ministry seems to intervene in the livestock trade, for different reasons and often at cross purposes. Equally important, the policies often work to the benefit of larger enterprises and vested interests, to the detriment of the smaller producer who the regulations are meant to assist.

It was pointed out that many livestock producers are slaughtering more cattle in response to a reduction in the size of their plot, a change in the crop mix, and an increased probability of theft. The government has introduced new credit programs to encourage livestock production, but many small farmers who do not have legal title to their land are either excluded from such credit or do not request it for fear that they will lose their land.

In Korea, the amount of arable land is very small and an emphasis has been placed, for strategic reasons, on the achievement of self-sufficiency in staple grains. Since 1965, however, rapidly rising per-capita incomes and population have led to a rapidly rising demand for beef and dairy products, as well as for pork and poultry. In attempting to meet this increasing demand, the government has faced difficult policy options, i.e., whether to encourage domestic beef production or import beef. The policies used have allowed both to occur. Tariffs have been imposed to limit imports and raise the domestic price of beef, which has risen faster then either that of pork or poultry. In response to higher beef prices, domestic beef production expanded nearly 10% between 1970 and 1978. However, beef prices were somewhat reduced and imports expanded and, after a substantial expansion of the cattle herd between 1970 and 1978, the herd has declined in recent years. Beef imports, which amount to only about 10% of total demand in 1970, amounted to about 25% in 1981. Nonetheless, because the domestic supply of bovine feed is very limited, higher domestic production has been possible only with rapidly rising imports of concentrate feed; increased beef production thus requires increased imports either of beef or of feed grains.

Korea still consumes only about one-third the amount of beef that is consumed in Japan, on a per-capita basis, and it is expected that beef demand will continue to rise rapidly in the future. The government hopes to increase production through special credit for livestock, including provision of long-term loans for pasture reclamation and development (on hills and mountains), by importation and dissemination of specialized beef and hybrid cattle, and by technical assistance, especially for improved husbandry and feeding (such as treatment of rice straw for forage). The government continues to set retail ceiling prices for beef and to allocate quotas for the

import of feed grains. It has not been concerned with any decline in draft power available, but has encouraged such mechanization as farmers select.

The paper for the Philippines presented evidence on and discussed the entire livestock sector, including cattle/buffalo (draft, meat, and milk), pork, poultry, and eggs. The government is trying to satisfy as much as possible of the growing demand from domestic production and had developed a number of programs to meet this need: credit, direct provision of livestock, and research and development in livestock breeding and disease and parasite control. The government has also expressed concern with technical problems, both in animal production and in pasture production and roughage usage. Public land policy is also under discussion as policy currently restricts use of range and natural pastures. The paper also presented econometric estimates of equations explaining the supply of livestock products, which could be useful to governments in formulating short-term policy measures.

During discussion, it was noted that many Philippine producers preferred small ruminants instead of large ruminants because they involve lower risk per animal in case of death or theft, stocks can be more closely adjusted to the availability of on-farm forage, and because, in the Philippines, this permits producers to avoid having to use common land grazing, which is fraught with government intervention. The turn-around time from gestation through fattening to sale is also shorter for small ruminants than for large.

Discussion also focused on Pakistan where substantial emphasis has been placed on development of the dairy industry through crossbreeding of Fresian–Jersey sires or imported semen with local Sahiwal cattle. Good results have been obtained. Artificial insemination has been subsidized heavily by the government. Additionally, good sires purchased by larger farms are usually used locally, and the government believes that this approach could also provide benefits in the future. Most of the animals are held by producers with less than 5 ha or by landless labourers.

Although efforts have been made to analyze seven to eight farming systems, there is still very little input-output information available to permit planning. Animal health is, nonetheless, believed to be a key issue for bovine development policy. Drenches, vaccines, and personnel are crucial. Credit lines have been established to facilitate livestock development, including interest-free loans in some cases, but small farmers either have not had sufficient collateral or have been afraid to mortgage their land and have not had other alternatives. Large farmers have obtained nearly all the land.

The milk marketing and processing system is very inefficient; there are many intermediaries, milk is frequently diluted and contaminated, and the farmer receives only a small amount of the final price. Government efforts to control prices encourage these inefficiencies. Price controls on hides and on wool have also created great disincentives to production.

The discussion centred on several themes. An effort was first made to categorize policies according to two groups, technical and economic, with issues like breeding, pasture development, use of nonconventional feed, veterinary programs, and improved farming systems in the former, and production incentives (prices, costs), marketing structure, commercial trade negotiations, government regulation (on animal use, etc.), and demand analysis under the latter. It was emphasized that although this separation is useful for enumerating policy areas, an integration of the technical and economic categories is badly needed in most countries. Economic policies, through the price structure, will largely determine which types of technological progress are profitable and which types of technical research are profitable. Coordination of price and research policy is essential. Similarly, economic analysis (using shadow

prices) can help biological scientists set research priorities by indicating where the cost/benefit ratio of research is likely to be greatest, i.e., concentrate on those production activities in which greatest value added originates, or where perceived scientific breakthroughs are expected to create very large productivity gains.

Although equity and efficiency are both important considerations for a government, many participants expressed concern that direct government intervention to regulate livestock markets, especially those concerning slaughter, would usually be counterproductive. Efforts to impede the slaughter of cull animals prior to a given age should reduce, not increase, the attractiveness of draft power and thereby reduce the number of draft animals available. This occurs because producers are sometimes forced by such regulations either to hold animals after their productivity is lower than their cost of maintenance thereby lowering the expected benefits from draft animal use, or evade such restrictions through surreptitious action, which again usually imposes extra costs on the producer. The beneficiaries of regulations are also often those who are already most privileged as they are best able, through their greater economic resources and knowledge and through their social and political connections, to either evade restrictions at lower cost or even profit from the market distortions that government regulation may create. The small, poorer producers who are the desired beneficiaries of government regulation are instead the least able to cope with the imposed distortion, and thereby harmed most.

Several participants also pointed out that rising beef prices may not be the primary or even a partial cause of declining cattle herds in Indonesia and Thailand. Other factors, on the supply side, are probably more important. These include the rise in the cost of labour, the shrinking size of farm plots (in Indonesia, especially), the rising probability of theft (in Thailand), improved transportation (making cattle less attractive for transport), and the desire for mechanization (either for reducing costs or avoiding labour administration problems).

Careful measurement is also required before the changes in livestock production can be determined. Use of slaughter plus the change in herd size, useful as an indicator for beef herds when productivity is relatively constant, is particularly inadequate when the end use of animals is rapidly changing (perhaps with rapid, relative price change of different end uses) and/or when animal productivity is rapidly changing. Quite possibly, it was hypothesized, producers have introduced greater improvements in animal productivity in recent years than have been captured by the rather crude GNP accounting techniques in most countries.

Veterinary programs are badly needed, and substantial public intervention is called for. Because of the constant contact among animals where smallholdings are dense, substantial externalities are present to parasite and disease treatments. Public subsidy and provision of treatment are badly needed.

Improved animal husbandry, through technical assistance and cooperative assistance, is both an important complement to any increased veterinary component and, perhaps, an independent source of improved animal health. New inputs (like drenches) will likely have little productivity unless producers are trained to use them well. Also, simple practices like improved cleaning of stalls and pasture rotation can reduce the need for parasite treatment.

Because animal health is such a substantial barrier to the export of beef and/or live animals, several participants recommended additional research on the means and economic profitability of disease control and eradication. Interesting work of this type has been done by Ellis, Jones, and Janke for Africa, and by Rubenstein for Latin America.

Research on Livestock Methods and Issues

Modeling Livestock Systems Under Tropical Conditions with Special Reference to Indonesia

Joel M. Levine[1]

Abstract. Two types of models are used: a biological and an economic model. The biological model traces the energy flow through the plant–animal system and the economic model reports on cash flows and calculates internal rates of return. Most biological and economic models reported in the literature are of improved systems and cannot simulate conditions of nutritional stress, extreme patterns of weight loss and gain, and reduced fertility that are common in the tropics. The scarcity of good tropical animal data makes it difficult to develop a biological model, but one example of such a model developed with data from the tropics is discussed. Triangular distributions of estimated values of unknown technical coefficients may be used in tropical economic modeling if it is understood that output is dependent on the assumptions made. Nine agroclimatic zones in Indonesia are identified, and the availability of livestock data is discussed. The basic investment in good data collection in these zones must be made if development is to proceed efficiently. Simple biological or economic models of village smallholder systems can be a powerful aid to development planning once the proper data are available.

Résumé. Les deux types de modèles utilisés sont le modèle biologique et le modèle économique. Le modèle biologique suit la circulation de l'énergie de la plante à l'animal tandis que le modèle économique rapporte la marge d'autofinancement et les taux de rendement internes. Presque tous les modèles biologiques et économiques s'adressent à des systèmes améliorés et ne peuvent simuler les conditions de stress alimentaire, les cas extrêmes de gain ou de perte de poids, les manifestations de fécondité réduite qui sont chose courante sous les tropiques. Le manque de données fiables sur l'élevage dans ces régions rend difficile l'établissement d'un modèle biologique ; aussi, le présent exposé analyse-t-il un de ces rares modèles. Dans la modélisation économique tropicale, il est possible d'utiliser des distributions triangulaires d'estimations de coefficients techniques inconnus, s'il est entendu que les extrants dépendent des hypothèses formulées. Il a été possible d'identifier neuf zones agroclimatiques en Indonésie et il est question de la disponibilité de données sur le bétail. Pour l'efficacité du développement de l'élevage, il est essentiel de procéder à une collecte exhaustive de données dans ces zones. Une fois les données adéquates recueillies, il sera possible d'établir des modèles biologiques ou économiques pour les petites exploitations de village, de formulation simple, qui constitueront une aide puissante à la planification du développement.

Two different types of models are commonly used to obtain information about livestock systems, and it is important to distinguish between them. One is called a biological model and the other an economic model. The biological model, developed by animal scientists, consists of a series of simultaneous equations that trace the flow of energy through the plant–animal system being studied, from the feed on offer, the intake of feed by the animals, and their weight change and subsequent production of offspring. The total energy entering the system (voluntary feed intake) must equal the total energy absorbed (maintenance requirements) and produced as end-product (weight gain and offspring). The most important driving variables for this kind of biological model are quality of feed on offer and liveweight of animals, but implicit in the model are assumptions relating level of quality of intake with quantity of intake and with efficiency of conversion of feed to metabolizable energy available to the animal. Assumptions that relate liveweight change of breeding stock to their fertility are most important. An example of a simple form of this model capable of being executed on hand-held programmable calculators, has been published by Levine et al. (1981) and Levine and Hohenboken (1981), which consists of four simultaneous equations and a frequency distribution relating liveweight to probability of conception. A much more elaborate version of this type

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of model has been developed by Texas A & M University (Sanders and Cartwright 1979a, b).

The economic model, used by agricultural economists and planners, simulates the composition of a herd or flock over time given different management and marketing strategies, and, sometimes, has linear programing components or is entirely a linear program. This type of model (Condliffe 1972; Juri et al. 1977) reports on cash flows and calculates internal rates of return for a given set of production and marketing conditions. Main driving variables for this type of model are costs and prices, but also implicit in the model are assumptions on fertility, mortality, and parturition interval. The economic model may be used on the farm or at the single production unit level or may model large production areas and entire countries or regions of the world. These two types of models have very different uses and require different data.

Modeling Under Tropical Conditions

Most biological models reported in the literature are models of improved or high technology systems. That is, animals have a high quality of feed on offer, do not suffer extreme patterns of weight loss and high compensatory gain, do not suffer from mineral or vitamin deficiencies, and, in general, are in a steady state or close to equilibrium condition (as measured by energy flows into and out of the system). Most economic models draw their technical coefficients (fertility, parturition interval) from data sets of improved production systems. It is common to find cattle ranches in Asia, Africa, or Latin America where the brood cows have calving rates of less than 50%. It is very difficult to find a biological model in the literature that can accurately simulate such production conditions or economic models whose technical coefficients reflect the reality of tropical conditions. There are two main reasons for this: data for productivity of cattle, buffalo, sheep, goats, swine, and poultry in the tropics are often not available; and modelers sometimes lack sufficient firsthand experience of the environment and production conditions they attempt to model.

In developing the biological model reported by Levine et al. (1981) and Levine and Hohenboken (1981) with data from the International Centre for Tropical Agriculture (CIAT) in Colombia, South America, feed intake and maintenance requirement equations, developed from an advanced production system, had to be modified to allow for the effect of phosphorus deficiency and sparse regrowth of newly burned savanna that reduced voluntary intake below that predicted by liveweight of animals and forage quality alone. These equations also had to be modified to increase voluntary intake and decrease maintenance requirements at the beginning of the rainy season to account for the high levels of compensatory gain that occur at that time of year. It was possible to perform these modifications, because a considerable amount of data from cow–calf and steer-grazing experiments had been collected over a period of 10 years. It is rare to find such a set of data in the tropics. Until such data have been collected in a given agroclimatic system biological models have very limited value.

Economic models, however, have different data requirements that can be more easily met in the tropics. As stated above, the main driving variables for this kind of model are costs of inputs (feed, medicine, and building materials) and market prices (slaughter stock, yearlings, weaned calves, lambs, etc.). These data can be quickly obtained for a given production system. The problem of assumptions on fertility, mortality, and parturition interval that are built into the model in the form of technical coefficients must be recognized. Where accurate data for these factors are lacking but estimates are known, good results may be obtained by forming triangular distributions of best estimate; high and low estimates, respectively; and by running simulations with sets of all possible combinations of estimates of unknown technical coefficients. For example, the calving rate of cattle in a given area may not be known accurately but thought to be about 50%, with a range of 30–70%, and mortality of breeding stock may be 10% with a range of 5–20%. Triangular distributions of 30–50–70% and 5–10–20% may be constructed and nine separate simulations run. This procedure only has value if the user understands that the output of a given run is a function of the assumptions made for a given set of technical coefficients (e.g., calving rate of 50% and cow mortality of 10%) and is not, strictly speaking, a simulation.

It is, therefore, critical that the user thoroughly understands the model being employed and the assumptions the model makes. Complicated models with subroutines within subroutines or "canned programs" that may be difficult to amend are usually not appropriate. Given these restrictions this kind of modeling can be a powerful tool that provides quantitative output for a given set of assumptions in a given production system. This quantitative output can assist greatly in management or planning decisions. It is usually not possible to use this procedure with biological models, because output of these models is often very sensitive to small changes in driving variables (particularly quality of feed on offer) or in assumptions that relate liveweight of breed-

ing females to probability of conception. Biological models, therefore, require a large data base in a given agroclimatic system to be used properly, and these data are usually not available in the tropics.

Modeling in Indonesia

Table 1 lists nine major agroclimatic zones of Indonesia, each with a distinct farming system. The most important distinction to be made is that between the densely populated inner islands of Java, Bali, and Madura and the rest of the country. As Dr Tillman (1981) has pointed out in his study of animal agriculture in Indonesia, the inner islands comprise 7% of the land area but contain 64% of the population, 66% of the cattle, 47% of the buffalo, and 85% of the sheep and goats. The inner islands also contain most of Indonesia's best soils, which are of volcanic origin, but much of the soil of the outer islands is of poor quality (podzollic). With a density of 685 persons/km^2 for the inner islands compared to 30 persons/km^2 for the outer islands (Tillman 1981) patterns of land use and farming systems are vastly different. The remaining major classifiers to distinguish agroclimatic zones in Indonesia are amount of rainfall (no dry season in West Java, Sumatra, and Kalimantan; dry season in Central and East Java, Bali, Madura, Sulawesi, Moluccas, etc.; and semi-arid to arid in Nusa Tenggara Barat and Timor) and altitude (highland and lowland). The highlands tend to be planted in estate crops (coffee, tea, rubber, cloves, and palm oil) and the inner islands in *palawija* (vegetables, corn, and cassava) where most of Indonesia's sheep and goats are. The lowlands tend to be cultivated in rice and also have most of the country's cattle and buffalo (Table 1).

Table 1. Major agroclimatic zones of Indonesia.

Inner Islands (Java, Bali, and Madura)
No dry season (West Java)
1. Lowland
   – Sawah, palawija,[a] buffalo, and a few sheep/goats
2. Upland
   – Estate crops (coffee, tea, rubber, and cloves), palawija, tree fruits, and many sheep/goats

Dry season (Central and East Java, Bali, and Madura)
3. Lowland
   – Sawah, sugarcane, corn, tobacco, cattle, buffalo, and goats
4. Upland
   – Estate crops (coffee, tobacco, cloves, and chocolate), palawija, and fat-tall sheep/goats

Outer islands (Sumatra, Kalimanthan, Sulawesi, Irian Jaya, Nusa Tenggara Berat and Timor, etc.)
No dry season (Sumatra and Kalimantan)
5. Lowland
   – Sawah, palawija, coconuts, ducks, and buffalo
6. Upland
   – Rubber, palm oil, forest, tree fruits, palawija, cattle, and goats

Dry season (Salawesi, moluccas, etc.)
7. Lowland
   – Sawah, palawija, cattle, and buffalo
8. Upland
   – Estate crops (coffee and cloves), cattle and goats

Semi-arid/arid (Nusa Tenggara Barat and Timor)
9. Coconuts and ranching (cattle, goats, and horses)

[a]Secondary crops: corn, cassava, and vegetables.

Data Availability

Given the nine major agroclimatic zones described above, each with a different type of land use, cropping system, and animal husbandry, what data are available from these zones to model livestock production systems? Based on 2 years' work and travel throughout the inner islands and Sulawesi and discussions with researchers and government officials from other areas of Indonesia it is the author's opinion that there are little or no data available in the outer islands for any of the major types of livestock with the exception of chickens of imported stock (*ayam ras*) raised in confinement systems. In the inner islands, some data are available for all classes of livestock (cattle, buffalo, sheep, goats, swine, and poultry), but relatively complete data sets, which include some information on fertility, mortality parturition interval, voluntary feed intake, genetic potential of different breeds under more than one environment, or efficiency of production in a given system, are available only for thin-tail sheep, *kacang* and *Ettawah-cross* (PE) goats, and *ayam ras*. These data were collected in the Bogor–Ciawi area near Jakarta by personnel of the Agency for Agricultural Research and Development (AARD) and an Australian government-assisted animal research centre or by personnel of Universitas Gajah Mada with assistance from the Rockefeller Foundation in DIY (Yogyakarta). At the present time, a limited amount of modeling can be undertaken with *ayam ras*, thin-tail sheep, and *kacang* and PE goats. Continuing to collect good data on sheep and goats, particularly goats in the outer islands, should remain a high priority as they are useful as sources of cash income for smallholder and landless rural inhabitants.

Modeling in the Inner Islands

Livestock holdings in the inner islands form part of an intensive farming system that uses livestock

for draft power, manure, recycling of by-products, and as a form of savings. Yet, there do not appear to be any modeling attempts reported in the literature that reflect the realities of this intensive system dependent as much upon cultural norms as market forces or concepts of biological efficiency. Simple biological models that simulate plowing with cattle and buffalo and trace nutrient recycling or economic models that explore marketing strategies as a function of religious festivals can be a powerful tool in understanding livestock systems as they actually are found in Indonesia and in identifying the constraints that limit their expansion or efficiency. Data collection must move from the experimental herd or flock to the village smallholder in the major agroclimatic zones where all of Indonesia's livestock are raised.

Recommendations for the Outer Islands

The dearth of data for all classes of livestock in the outer islands is a serious constraint to the development of improved and expanded livestock production in Indonesia. With their low densities of population and vast areas of *alang-alang* (*imperata cylindrica*) grasslands, the outer islands possess the physical resources and potential for a tremendous increase in ruminant animal production (Levine 1981).

There are many development projects planned or already being executed in Kalimantan, Sulawesi, Sumatra, Nusa Tenggara Barat, Moluccas, and Irian Java, which have collectively, nearly U.S.$70 million/year over the next 5 years budgeted specifically for livestock development or the provision of draft animals to transmigrants and indigenous settlers, yet these projects are being executed without any real knowledge of which breeds are most suitable in a given area, what feeds are available, and what will be the return to the producer for a given "package" of improvements. Basic production data in the major agroclimatic zones of the outer islands must be collected if efficient and intelligent development is to take place. Many development projects already contain requirements that a base-line survey be conducted to determine the economic well-being of the target population at the beginning of a development program, and again, at the end, so that the donor or lending agency can calculate an internal rate of return. This requirement should be expanded to require sufficient monitoring of a given farming system so that basic production data of the important crops and livestock can be determined accurately. As these data are collected, it will be possible to know what is the chief constraint to increased production: disease, feed supply, inferior breeds, credit, or marketing, and development planning can take place in a much more intelligent atmosphere. Research, drawing on this information, can be more realistic if it addresses the constraints identified.

If the donor agencies that finance much of the large outer island development projects support this procedure and provide budgets for it in their proposals, the network of branch stations of AARD, of local Directorate General of Livestock Services offices, and of provincial universities can carry it out. The investment in time and budget for this type of data collection must be made.

Livestock Development Projects: the Nepalese Experience

Ram M. Upadhyay[1]

Abstract. Nepal has one of the highest livestock populations per household in the developing countries of the world. The productivity of livestock, however, is very poor because of poor nutrition, inadequate health services, poor genetic potential, inadequate extension services, and the lack of proper marketing channels. The Department of Livestock Development and Animal Health is the main institution responsible for livestock development, and the Dairy Development Corporation is responsible for collecting, processing, and marketing milk and milk products. The main objectives of livestock development projects in Nepal are to improve animal health and production to increase rural income and employment, improve human nutrition, and reduce imports. The main strategy for livestock development is to encourage better utilization of existing and improved feed resources, improve the genetic makeup of livestock, provide better animal health services, and provide better marketing channels. Livestock development projects should focus on long-term policies, labour training programs, and ensuring that adequate financing is available for the successful completion of the projects.

Résumé. Parmi les pays en développement, le Népal est celui où le nombre de têtes de bétail par foyer est le plus élevé. La productivité dans ce domaine est toutefois très faible en raison de la mauvaise nutrition, des services de santé insatisfaisants, du faible potentiel génétique, de la médiocrité de la vulgarisation et de l'absence de circuits de commercialisation appropriés. Le Ministère du développement du bétail et de la santé animale (Department of Livestock Development and Animal Health) est l'institution principale responsable de la mise en valeur du bétail tandis que la Société de développement laitier (Dairy Development Corporation) est chargée du ramassage, du traitement et de la commercialisation du lait et des produits laitiers. Les objectifs principaux, au Népal, sont l'amélioration de la santé animale et la production de bétail pour l'accroissement de l'emploi et du revenu en milieu rural, l'amélioration de l'alimentation humaine et la réduction des importations. La principale stratégie de développement du bétail consiste à encourager une meilleure utilisation des ressources en alimentation animale, telles quelles ou améliorées, de veiller au progrès de la génétique du bétail, de procurer aux animaux de meilleurs soins de santé et d'améliorer les circuits de commercialisation. La mise en valeur de l'élevage implique des politiques à long terme, des programmes de formation de main d'œuvre et l'existence d'un bon système de financement pour le succès de l'achèvement des projets.

The Nepalese economy is mainly based on agriculture, which provides about 90% of employment and almost 70% of the gross domestic product (GDP). Livestock forms an integral part of the agricultural production system, providing almost all of the draft power needed for cultivation, hauling, and transport of agricultural products as well as providing manure and compost. Livestock products (mainly milk, meat, skins, and manure) provide an estimated 15% of the GDP. The export of livestock products, mainly ghee, is estimated at U.S.$2 million/year. Imports of milk products (mainly milk powder, baby food, and other milk preserves) and male buffalo and goats for slaughter are valued at about U.S.$10 million/year. Livestock play an important role in the subsistence economy of rural Nepal, and milk and milk products mainly from buffalo and some from cows, yaks, and chawries (a crossbred female progeny obtained by crossing yak (*Bos gruniens*) and cattle (*B. indicus* or *B. taurus*)), are a very important part of the diet and are a major source of animal protein. Dried yak meat and chawries are kept as a source of food throughout the year in the hill areas of Nepal. Ghee, produced from the milk, is used mainly as a base for cooking and as a source of cash income for the hill people of Nepal. Dung is used primarily for making farmyard manure and compost for fertilizing the land in the hill areas and in Tarai,

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a relatively flat lowland area; it is also used as fuel for cooking when firewood is in short supply.

Livestock Production Constraints

The number of livestock kept by rural households in Nepal is among the highest in the developing world. The average rural household is composed of 5.8 persons, and each household maintains an average 3.8 cattle, 1.6 buffalo, and 2.7 goats/sheep (1972 Nepal Agricultural Sector Survey). The number of livestock holdings per household compared with the average arable land holding of only about 1.7 ha in the flat lowland area of Tarai and 0.4 ha in the hills, results in an inadequate supply of feed and fodder and is the major constraint to livestock production. An important factor that contributes to the high density of the livestock population is the fact that slaughter of cattle and all other female livestock is prohibited by law and is subject to religious constraints. This has led to the accumulation of large numbers of unproductive cattle and has placed severe stress on the fodder supply available for productive animals.

Thus, the excessive pressures exerted on scarce land resources in the hills and Tarai area have caused serious deterioration of natural grass cover. In the hill areas, this has led to widespread soil erosion and the replacement of the more nutritious species of pastures with species of lower productivity and palatability. In the Tarai area, as more land has come under cultivation and pasture areas have deteriorated or even vanished, livestock nutritional requirements are increasingly met by the use of crop residues (straws and stovers) and the limited feed available along roadsides and on paddy lands and bunds.

The increasing human population has resulted in a decrease in the availability of food grains for human consumption and in ever-decreasing supplies of food grains and their by-products for use in livestock feed. Unrestricted exports of food and industrial by-products and the absence of a coordinated approach to scientific analysis and use of these by-products in livestock feed have further worsened the situation. Very little supplementary feed is given to the livestock and is generally fed only to the milking and working animals.

The lack of labour and adequate facilities has resulted in poor animal health services in Nepal. Internal parasites, particularly liverfluke, are perhaps the greatest single factor affecting the production of livestock. Hemorrhagic septicemia in cattle and buffalo is also a cause of high mortality rates. Foot and mouth disease in ruminants is a growing problem and causes substantial economic losses by reduced production and reduced working days. Rinderpest has been successfully controlled. Foot rot is a major disease of sheep, and New Castle disease causes very high mortality in poultry.

In general, the livestock population of Nepal has very low genetic potential, which is reflected in low yields of milk and meat. A cow produces about 150 L and a buffalo about 300 L of milk per year according to a rough estimate arrived at by the Food and Agriculture Organization of the United Nations (FAO). The age at first calving and calving intervals are relatively extended.

The Department of Livestock Development and Animal Health has been recently established under the Ministry of Agriculture. The Department, however, does not possess enough trained personnel to carry out effective livestock development work. Marketing channels for livestock products are also very poor, particularly for perishable products of animal origin. This severely restricts production and results in unmarketable surpluses in some areas and shortages in main consumption areas.

National Livestock Development Plans/ Projects

During the sixth Five Year Plan (1980/81–1984/85), Nepal aims to increase overall national livestock production by improving the productivity of individual livestock through improved animal health services, introduction of improved breeds of livestock, and improving the general management feeding and livestock extension activities. To use the valuable scarce resources in an effective way, projects have been identified on a potential, selected-area basis. All the resources are to be identified in selected areas to promote appropriate livestock development. The sixth Five Year Plan proposes to increase milk production by 24%, meat production by 20.7%, and egg production by 53.7%/year.

The Department of Livestock Development and Animal Health holds the overall responsibility for livestock development. It has four regional and several district-level offices responsible for general livestock extension and animal health services. Several livestock farms are engaged in the production of improved genetic materials and other inputs like fodder seeds and planting materials. The Department also has training programs for low- and medium-level technicians. The Dairy Development Corporation is under the jurisdiction of the Ministry of Agriculture and is responsible for organizing milk collection, processing, and marketing where feasible throughout the country.

Nepal has launched its first livestock development project with the aid of an Asian Development Bank (ADB) loan of U.S.$9.2 million spread over 5 years. The European Economic Community (EEC) has provided a grant of U.S.$3.08 million to finance the local currency investments. The Australian government and the United Nations Development Programme (UNDP) have also provided grants to finance fellowships and consultants' services. There are several other area-based projects generally known as Integrated Rural Development Projects financed by several multi- and bilateral agencies in which livestock development activities are integral parts. Such projects are spread all over the country and are monitored by the Department of Livestock Development and Animal Health.

The main objectives of the livestock development projects are to improve animal health and production in Nepal to increase rural incomes, particularly of smallholder farmers; increase rural employment; improve human nutrition; and to reduce imports of essential food commodities of animal origin. To achieve these objectives the livestock development projects must be designed to eliminate the major constraints affecting livestock production and productivity, namely the poor quality and insufficient quantity of livestock feed, the low genetic potential for milk and meat production of the indigenous livestock, the high incidence of disease-related deaths and loss of production in animals, and the lack of suitable marketing channels for livestock products in many areas of the country. The main strategies for livestock development projects are to: encourage better utilization of existing feed resources, introduce better varieties of feeds and fodder, and extend production; replace the existing poor-quality livestock with improved breeds of livestock; protect livestock from disease-related deaths; and organize marketing channels suitable for providing guaranteed and regular markets for livestock products, particularly milk and milk products.

Factors Affecting the Return From Livestock Development Projects

All livestock development projects aim at achieving the above objectives; however, the expected returns from investments in livestock development projects are not always realized. For example, political considerations are often responsible for implementing projects that do not consider the effective use of scarce resources, and funding agencies can only provide short-term financial assistance that is ineffective in producing returns from livestock suffering from malnutrition and disease. Financing agencies also use field experts and consultants from outside the country who often have little or no knowledge of traditional, cultural, social, and environmental aspects of the country, which results in inappropriate technology stemming from a lack of firsthand experience. These agencies are generally concerned with making substantial investments in projects. This factor very often results in investing in items like very sophisticated equipment, vehicles, and the services of experts and consultants, which are not always necessary and are often inappropriate and mismanaged. As a result, projects often reflect the misconceptions of the agencies and not the needs of the recipient country.

All of the above factors have an effect on the success of livestock development projects, because they do not take into consideration the use of scarce resources, sufficient time, and long-term financing. Livestock development is a slow and complicated process. It cannot be achieved through short-term measures. The tendency of the financing agencies, however, is to create implementing agencies for short-term projects that are afforded more flexibility in their operations but cause internal conflicts within the existing government structures in the same field who have less authority and privileges.

The organization of an implementing authority also very often suffers from the above defects. It is often the practice to create an organization within an existing government framework that is provided with extraordinary powers and privileges. These privileges are thought to be conducive to effective implementation of the projects but result in professional rivalry and indignation among other government personnel.

The experience in Nepal shows that although there is an immediate need for skilled labour and technical expertise it requires long-term planning by the government to provide the necessary training facilities to increase the supply of qualified local expertise and labour. Consultants selected by the financing agencies are not much superior to the local expertise and need time to familiarize themselves with the local situation, which can be time-consuming and frustrating for the local experts.

Procedures governing the procurement of goods and services are also often quite complicated. Withdrawals and reimbursement procedures are equally complicated and cause considerable delay in procuring essential goods and services and the expected return from these projects.

Monitoring and evaluation of these projects are coordinated by the financing agencies who use sophisticated management practices not very often employed by countries like Nepal and cause more delay in the release of funds, etc., which affects the desired return from a project. Most of the projects are left

without any effective follow-up measures after the project financing period is over. Therefore, the investments and activities being supported by the flow of inputs from local and foreign technicians ceases and the project is at a standstill. Government resources alone are inadequate. Without continued financial support, the long-term projected returns from these various projects cannot be realized.

Conclusion

Livestock development projects should:

- Use scarce resources as efficiently as possible;
- Be designed over a sufficiently long period to be able to see a tangible return in investment;
- Use local expertise to coordinate, evaluate, and implement the projects with the minimum of assistance from foreign consultants;
- Spread the finances throughout the long implementation period;
- Be organized under the existing organizational framework of the particular government agency;
- Have a program to train the required personnel;
- Use as far as possible local expertise as consultants; and
- Be provided with follow-up activities and sufficient financing after the project implementation phase.

Small Ruminant Production in West Java: Methodology and Initial Results

N. Thomas, W. Mathius, and M. Sabrani[1]

Abstract. An upland and a lowland site were selected in West Java for the study of small ruminant production on small farms. Data were collected in baseline and monitoring surveys and analyzed to determine the relationship between animal production and the principal environmental and farm variables. Major differences occur between sites in terms of farm characteristics, animal production technology, and flock characteristics; although initial analyses suggest that individual animal productivity is very low and the same at each site. The methodology was examined for efficiency and reliability in achieving survey objectives, and certain improvements were suggested. The value of an interdisciplinary approach was emphasized.

Résumé. Deux sites, l'un dans les basses terres, l'autre dans les plateaux de Java-Ouest, ont été choisis pour l'étude de la production de petits ruminants dans les fermes de taille modeste. Des études de référence et de contrôle ont permis le rassemblement de données qui ont été ensuite analysées pour déterminer la relation entre la production animale et les principales variables constituées par la ferme elle-même et par l'environnement. Ces sites présentent de grandes différences au niveau des fermes, des techniques de production animale et des caractéristiques des troupeaux, bien que les premières analyses permettent d'affirmer que la production animale est faible et semblable dans l'un et l'autre sites. Les méthodes employées pour atteindre les objectifs de l'étude ont été examinées des points de vue de l'efficacité et de la fiabilité et certaines améliorations ont été proposées. L'approche interdisciplinaire de la recherche a contribué à valoriser les résultats.

As in many Asian countries, the majority of the Indonesian rural population is involved in small farm agriculture. Rice and cash crop farming are two of the major activities of this sector, large-scale estate and forestry production is the third. The predominance of small farms in the agricultural sector means that they are an essential component of any long-term agricultural development strategy. The characteristics of the small farm leave little flexibility in terms of alternative production strategies available to the farmer. In general, farmers must respond to shrinking land, capital and availability of other resources, inadequate institutional infrastructure, and other constraints. Most of the farmer's present technology is low-input and spread across different enterprises, so that although each enterprise is open to improvement it is questionable as to whether an improvement in only one will significantly improve farmer welfare.

The development of research policy for such small-scale units requires an understanding of the complexity of production in the village context because the farm and community are strongly linked. Each is subject to a variety of environmental, institutional, and cultural factors that will define possible paths to development. As Harwood (1979) states: "The farming system is a set of biological processes and management activities organized with the available resources to produce plant and animal products." Intrinsic differences between farms and farmers suggest that a single strategy will not provide sufficient flexibility for the benefit of the whole community.

The present study describes the implementation of an interdisciplinary research program designed to define present small farm technology with respect to a specific enterprise, identify the major constraints limiting production, and develop alternative tech-

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nology that would remove these constraints and allow increased productivity. Small ruminant (sheep and goats) production was defined as the study enterprise, and a large proportion of Javanese small farmers are involved in this activity.

Methodology

Because of the prior specification of the structure of the program in terms of the research disciplines involved, program development has concentrated on the design of a framework to cover both the aspects of implementation of a village research program and the links between the different disciplines involved. The major disciplines collaborating in the study include animal nutrition, animal breeding, sociology, and economics. As an inevitable polarization occurs between the biological and social investigators in terms of approach and actual field activities, an attempt has been made to relate these areas in a conceptual framework for the program. As a result, although the sites and farms selected for study are common, data collection activities are independent, care being taken only to ensure that adequate cross-reference may be made between disciplines in the analysis and interpretation of the data. The linkage between disciplines is provided by defining a hierarchy of goals and objectives, which become increasingly specific as the role of the individual within the program is defined. Research priorities for the nutrition and economics disciplines are shown in Table 1.

The design of the village research program has followed the pattern suggested by Norman (1978): (a) a descriptive or diagnostic phase in which description of the existing technology is carried out and an initial assessment of production constraints is made; (b) the design of new or appropriate technology through research at the village, station, and laboratory level; (c) the evaluation of a newly created technology at the village level; and (d) the transfer of field-tested technology to a wider range of sites.

Table 1. Research priorities for nutrition and economics disciplines within the Small Ruminant Collaborative Research Support Program (SR-CRSP) framework.

Level	Goals	Objectives
Program	–Transfer of improved small ruminant production technology to the farmer as a means of improving his welfare	–Determine production technology –Determine small farm growth potential and identify development variables –Verify implementation process –Improve research capability through training
Discipline	–Develop improved feed technology	–Determine dietary constraints to village animal production –Define seasonal feed availability –Define linkages between crop and animal production
	–Define parameters for technology transfer	–Define location-specific economic variables –Determine importance of animals as component of farming system –Determine economic constraints to animal production –Determine strategies for technology transfer
Researcher	–Define seasonal patterns of feed quality	–Determine protein, fibre, and mineral composition of samples from farms
	–Define species composition and feeding value of farm rations	–Determine major nutrient contribution of different species in ration
	–Define use of crop residues in feeding	–Quantify production of SR on farms and alternative diets
	–Determine strategies for feed resource development	–Quantify on-farm availability of crop residues and proportion used in feeding
	–Develop production, marketing and credit models	–Quantify institutional and community constraints to small ruminant production
	–Define development strategy from tested models	–Determine production risk, marketing credit/ contract systems –Determine price, supply, and demand formation –Determine farm consumption behaviour

Note: The goals of the researcher and discipline levels link directly to the objectives of the discipline and program levels, respectively.

Initial activities involved the process of site and farm selection. The major characteristic required in any site selected for intensive study is that it be representative of a larger area in which technology transfer is ultimately intended. Equally, if major differences exist between regions, there is a considerable advantage to the selection of more than one site in terms of the contrast between them.

The major physical factors affecting agricultural patterns under Indonesian conditions are precipitation (duration and intensity), elevation, slope, and soils. As the initial phase of the program has been confined to West Java, and major differences can be found in all these factors in different regions of this province, selection has been on the basis of two major sites that exhibit the greatest contrast possible in each factor. The upland and lowland sites selected are described in Table 2.

Because of constraints that affect the implementation of a research program, the study villages within each major site were selected on the basis of the following factors: representative of site in terms of agricultural activities, willingness to cooperate by village heads and local officials, stability of the political situation, ease of access, mean animal population density, and access to market. The subjective nature of some of these criteria makes it difficult to assign priorities to them in terms of importance. However, as program development depends on institutional cooperation, it is doubtful whether any program could select sites by objective criteria alone. Table 2 also includes the general characteristics of the villages selected in each location.

As the purpose of the program is to concentrate on small ruminant production only, the procedure for farm selection was based on factors considered to be important to the management of such an enterprise. It was necessary to be able to distinguish between farms in terms of possible resource limitations, as the pattern of any enterprise will reflect this. A two-stage process was, therefore, carried out: a stratified sample survey was made of all small ruminant producers in each site, on the basis of the distribution of farm size (this sample was intended for a baseline survey, with the objective of quantifying the farm resource base), and a selected sample survey was made from the original stratified one, on the basis of farm size and the willingness of the farmer to cooperate, for long-term study of the dynamics of on-farm animal production. The criteria for stratification and the number of farmers defined by the sampling procedure for each stratum are shown in Table 3.

Although the number of animal producers in the upland area was sufficiently large that a stratified sample was defined (following Cochran 1977), fewer farmers in the lowland area were found to keep sheep or goats, and it was possible to make a total survey of these producers for baseline purposes. All data-collection activities at the farm level were conducted by a cadre of trained technicians who lived in the study villages. The time spent by the farmer

Table 2. Characteristics of the village sites selected in the upland and lowland regions of West Java.

	Upland (Garut)		Lowland (Cirebon)	
	Tenjonegara	Sindangratu	Kartasura	Purwawinangun
Altitude (m)	>600	>600	<10	<10
Topography	Rolling/steep	Rolling/steep	Flat	Flat
Area (ha)	1438	736	415	665
Population	5485	7555	4130	6288
Number of families	1566	1930	936	1392
Population density/ha	3.8	10.3	10.0	9.5
Cultivated land (ha)	846	649	366	445
Wet rice	105	154	366	391
Dry land	741	495	—	54
Other				
Estate	—	—	—	—
Grazing	—	—	—	14
Garden	45	72	42	1
Unspecified	443	—	—	—
Small ruminants	2028	1900	166	443
Small ruminants/family	1.30	0.99	0.18	0.32
Small ruminants/ha of cultivated land	2.40	2.93	0.45	1.00

Table 3. Farm size strata and resulting distribution of farms between strata on the basis of owned and rented land (ha) for small ruminant producers in the upland and lowland regions of West Java.

Strata (m^2)	Upland			Lowland		
	Owned (ha)	Farmed (ha)	Number of farmers	Owned (ha)	Farmed (ha)	Number of farmers
0–200	0.01	0.01	10	0.01	0.01	19
201–1500	0.06	0.11	21	0.04	0.04	30
1501–3000	0.16	0.21	37	0.21	0.21	2
3001–10000	0.38	0.53	71	0.34	0.55	35
>1 ha	1.33	1.67	6	1.12	1.92	14

away from the home in different farm activities required the presence of program staff outside normal working hours so that data collection could be achieved at the farmer's convenience. The baseline survey activities were conducted from August to November 1980, and the long-term studies began in early 1981.

Results

Djajanegara et al. (1982) have examined the pattern of sheep and goat ownership and the sources and diversity of feeds, and find distinct differences between sites (Table 4). According to De Boer et al. (1982), the baseline survey data also indicate a significant relationship between the amount of land farmed and flock size at one of the locations and, from estimated age–weight relationships, a different pattern of animal growth at the two sites. On the basis of this initial evaluation of the baseline data, the criteria used to differentiate between sites, therefore, appear to have been successful in the definition of sites with fundamental differences in animal production.

Subsequent fieldwork, using a reduced number of farmers for a series of repeated measurements over time, has yielded data independent of the baseline survey, allowing separate analysis of some of these parameters. Table 5 shows daily liveweight gain (LWG) for animals grouped into three weight categories at each location representing the total animal population of the reduced sample. No difference exists between locations for daily LWG calculated as a mean for all animals in each class. A significant difference ($P<0.05$) exists only in daily LWG between the lightest and the other categories. This occurs at both sites. The number of animals in each category suggests that the subsample selected from the baseline population is homogeneous between locations, and separate analysis showed that the mean liveweight of each class was not significantly different between locations.

An additional analysis of the baseline data for the relationship between total land farmed (ha, x) and flock size (number of mature animals, y) yielded

Table 4. Patterns in sheep and goat ownership, management, and feeding in upland and lowland sites in West Java.

	Upland	Lowland
Number of adult animals per farm family		
Sheep	2.82 (±2.54)	4.80 (±3.98)
Goats	—	2.16 (±1.11)
Percentage of farms using grazing (g) or confinement (c)		
Sheep	99 c : 1 g	26 c : 74 g
Goats	—	100 c
Percentage of farmers using different sources of feed		
Family farm	70	15
Uncultivated land	30	79
Public land	—	1
Purchased	—	5

Source: Djajanegara et al. (1982).

Table 5. Pattern of animal growth as daily liveweight gain (g) for different weight classes in sheep and goats on farms in the upland and lowland regions of West Java for a 30-day interval during September and October, 1981.[a]

Weight class (kg)	Upland		Lowland	
	gLWG d^{-1}	Number[b]	gLWG d^{-1}	Number[b]
0–10	72.3a	18	78.2a	22
10–20	34.4b	31	28.6b	42
>20	24.0b	94	14.8b	91

[a]Farms represent a stratified sample based on size of land holding. No statistically significant difference exists between locations for the mean of animal liveweight per class. In the table, means followed by a common letter are not significantly different ($P<0.05$).

[b]Total number of animals of each category on the 30 upland and 28 lowland farms studied.

equations of little predictive value (upland, $y = 1.09 + 0.22 \log_e x$, $r^2 = 0.02$; lowland, $y = 2.43 + 0.11 \log_e x$, $r^2 = 0.01$). The significant relationship found for the upland site by De Boer et al. (1982), using a linear model and a flock size based on total animal units, was slightly more useful ($r^2 = 0.08$). Both analyses show that the major part of the variation in flock size is still to be explained. Other factors, such as family size or cropping pattern, may be more useful for explanation.

In general, it appears that the greatest difference between locations is to be found in flock parameters and in the major factors of technology, such as the feeding system. Flock size has not been found to be substantially related to a single parameter, such as farm size, and is probably determined by a complex of factors. Under the conditions examined, individual animal growth does not appear to respond to differences in the technology of production.

Discussion

The development of the methodology used in this study was based on the premise that a certain sequence of activities is required to be able to identify current production technology, define constraints to production, and develop alternative technology superior to the current practice. An important strategy was the selection of multiple sites differentiated on the basis of fundamental agricultural parameters. It was thought that such sites would allow a comparison of the efficiency of different technologies in the production of the same commodity.

Although the selected worksites are demographically and geographically distinct, and baseline survey data show marked differences in the composition of the small ruminant enterprise in terms of structure and management, deeper analysis suggests that the fundamental unit of the animal enterprise, the individual animal, performs similarly at each site. This poses two problems. First, is the baseline survey indicating a different result than the subsequent study, and second, if the animal is performing similarly under two distinct environments what value is there in distinguishing between locations on the basis of factors that apparently do not affect animal production?

Common parameters are considered by the baseline and subsequent study, but the former emphasizes animal population parameters such as flock size, whereas the latter looks more closely at the biological element of the flock. If each study is confined to these parameters, the second study adds an extremely important insight to the first, i.e., that the animal and the flock are independent yield components of the animal enterprise. The difference in interpretation of the same animal parameters from the different surveys is felt to be due largely to differences in perception of researchers from different disciplines. However, it is important to note that a set of single observations that aims to describe the status quo of a particularly dynamic type of farming system is open to considerable difficulty in interpretation. If stratification does not lead to improved quantitative relationships between major parameters, as a result of reduced within-stratum variance, such interpretation is more difficult. Repeated measurements offer more reliability and provide a means of accounting for differences in practical methodology at different locations by using the changes in the absolute values as the quantities of interest, rather than the absolute values themselves. In defence of the baseline survey, it should be pointed out that selection within the baseline population for the subsequent studies could have resulted in a biased sample, although the similarity of results at the two locations suggests that this is probably not so.

A basic premise in the stratification of the farm population on the basis of size was that a large farm provides a greater possibility for farmers to meet the feed needs of their flocks than does a smaller one, and if the feed resource is a major constraint to animal production there should be a relationship between farm size and flock size. The lack of any apparent relationship can be interpreted from the feed source analysis of Djajanegara et al. (1982), where it was shown that in both sites a large proportion of the farmers obtained their feed from off-farm locations and, even where a significant amount of crop by-products is used, nonfarm-produced forages still contribute substantially to the diet of the flock.

The parameters selected for stratification of site and farm were ones commonly used in agronomic studies and are known to be important in the determination of cropping strategies. If mixed farms are the major type to be found in a region, it is natural to assume that the nature and productivity of the animal enterprise will vary in some proportion to the crop ones. The value of the present study is that, in the case of West Java, although flock parameters do vary for the period studied animal growth was similar.

A farm enterprise can be broken down into three main elements: technology (management), productivity (biological conversion of input into output), and interaction (the exchange of resources between enterprises). For an animal enterprise these elements are described as in Table 6. The differentiation between sites has provided clear differences in the elements of technology. By inference this also leads to

Table 6. Elements of an animal enterprise under small farm conditions.

Technology (descriptive)
Animal species/breed, flock size, flock composition, breeding management, feeding system, health care, housing type, labour input, cash input, and marketing
Productivity (quantitative)
Animal
–Individual parameters: Liveweight gain, feed conversion, and prolificacy
–Flock parameters: Reproductive performance, mortality, offtake (no./weight)
Feed
–Origin, type, quantity offered per animal, and feed quality
Sales/consumption of main products and by-products
Interaction (quantitative)
Interchange of physical resources (feed/manure), substitution of purchased inputs, distribution of labour, and utilization of capital from animal/crop sales

a difference in the interaction term, although this has not been quantified. However, the integration of the components of technology, through distinct feeding systems in each case, has resulted in the same animal output on an individual basis. This implies that the animal is unable to express its plasticity under these conditions and that growth at the rates found is not a significant component of flock productivity. One of the major flock parameters is its reproductive rate, which describes the potential rate of increase of the flock and, thus, the potential turnover of animal numbers; the individual contributes to this through the degree of prolificacy that it exhibits. The difference in flock size and species composition between the two sites represents major factors that will influence the performance of a flock and, under conditions where the animal is constrained to a low level of performance, represents the main strategies available to farmers for adapting their enterprises to their own conditions.

Conclusions

The difference in perception between researchers as a consequence of their disciplinary background can result in differences in interpretation of survey results. Different disciplines put different emphasis on the type of data required and the methods used in data collection. An interdisciplinary approach is essential if all aspects of a small farm enterprise are to be studied with precision.

This study suggests that an animal enterprise has several components that influence productivity. Both technology and flock characteristics were different between locations, but individual animal productivity was similar. Feeding management, as a component of technology, was different at each location, but constraints in feed quantity or quality effectively eliminated these differences in technology. Recommendations are that:

- Programs should avoid differences in interpretation arising from the disciplinary background of the researchers. This approach requires a combined approach to interpretation by the collaborating disciplines;
- Initial survey activities should be used to provide further information for stratifying the sample population on the basis of parameters found to be quantitatively related to the enterprise under study; and
- Interpretation of quantitative parameters that relate to the biological element of the farm enterprise should be made from measurements repeated over time rather than from a single set of absolute values. This period should cover those times when the constraints imposed by the environment are alternatively at their maximum and minimum.

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Technology Changes and Livestock Development in Asia

Hubert G. Zandstra and David J. King[1]

Abstract. Most animal products in Asia are still produced on small farms. Research emphasis should be placed on increasing livestock production of cattle, goats, sheep, and buffalo of small farm households because only domestic ruminants can consume low-quality crop residues. Ruminant production on small farms in Asia strongly interacts with crop production enterprises. Farming systems research has been extended to farming systems that include animal production. It has been developed in such a way that the site selection, description, testing, multilocation testing, and production program formulation phases are conducted on local sites. The research priority for increased livestock production is to develop efficient forage crops and by-products based on year-round feeding systems. This requires increased collaboration of production economists with crop specialists and animal nutritionists. Research by economists and other social scientists is also needed to determine market opportunities for and constraints to increased production, input costs and availabilities, and the likely farm household responses to increased livestock production opportunities through modification of farming systems utilized and the use of household time and resources on nonfarm activities. Research by economists is also needed on the agricultural sector, regional development, and social or equity policies that affect the relative prices of crop and livestock products and factors of production for particular socioeconomic or regional groups of farmers. Agricultural and social scientists must collaborate to realize the full potential of increased livestock production.

Résumé. En Asie, la production animale est concentrée dans les petites fermes où elle est associée à la production agricole. La recherche devrait tendre à accroître le cheptel, chèvres, moutons, buffles, qui peuvent se nourrir de la recherche sur les systèmes culturaux a donc été élargie à cette pratique. Le cadre, les activités et les instruments de recherche ont été créés de façon telle que le choix du site, sa description, son caractère, les tests, en plusieurs endroits, les phases de formulation du programme reflètent l'environnement et les conditions socioéconomiques de l'exploitant. La priorité accordée à cette recherche devrait déboucher sur la production de fourrages et de sous-produits agricoles pour assurer l'alimentation des animaux toute l'année. Cet objectif exige une participation accrue des économistes de la production avec des experts en alimentation animale. Il faut que des économistes et des spécialistes des sciences sociales conjuguent leurs travaux pour déterminer les possibilités et obstacles de la commercialisation d'une production accrue ; les coûts des intrants et les disponibilités ; la réaction du fermier à cette augmentation qui modifie les systèmes culturaux et l'emploi du temps et des ressources du foyer à des activités non-agricoles. Les économistes devront se pencher sur le secteur agricole, le développement régional, les politiques sociales ou de capital qui influent sur les prix relatifs des récoltes et du bétail sur pied et des facteurs de production, pour tous les petits fermiers. Les scientifiques de l'agriculture et des sciences sociales doivent collaborer afin que l'augmentation de la production animale profite au développement du secteur rural.

Since the 1950s, specialized animal production in Asia has become substantially more common for nonruminants, particularly swine and poultry. Nonetheless, the great majority of animal products is still produced on small farms. This paper will emphasize, therefore, livestock production on small farms and some issues related to improving the contribution of that enterprise to farm productivity. Particular emphasis is placed on the role of production economists and their colleagues involved in planning and sector policy formulation in research aimed toward increased livestock production.

Research on and a thorough analysis of the existing productions systems is an essential step in the improvement of mixed farming. This description and the conditions drawn from it in terms of the im-

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portance of animals in the farm enterprise have on the one hand often ignored hidden contributions to the crop or off-farm enterprises and on the other hand failed to estimate the opportunity costs in terms of either farm or nonfarm activities that have to be curtailed or foregone if animal production is to be maintained or expanded. It is important that these considerations as well as technological development of livestock production be considered in developing a research orientation for livestock sector analysis and policy formulation.

Research Orientation

Animal production has many facets that should be considered in the development of a research orientation. Certain activities should receive attention at central research locations. These concern factors that require costly research inputs and that are not greatly affected by changes in the production environment. Other activities concern factors that interact a great deal with climate, land resources, and farm type. These should receive attention at a local level and relate to a specific production system or target area. When considering research priorities, it also becomes evident that certain factors do not become limiting until other constraints to the existing production system have been removed. In addition, certain research activities lend themselves to a disciplinary approach, whereas others demand a closely coordinated effort by a team composed of several disciplines.

Animal Species

It has been recommended that research focus primarily on domestic ruminants (Hulse 1981; Winrock 1981), because only ruminants can utilize land that is not suitable for food crops and low-quality crop residues for the production of milk, meat, draft power, manure, hides, and fibre. They compete less than other animals for land and agricultural products that are needed for human food production. To the extent that ruminants are used for milk production, they are one of the biologically most efficient means of producing animal protein and in many small farm systems depend on minimal input of (fossil) energy (Spedding 1979). In Asia, cattle, goats, sheep, and buffalo should, therefore, receive major attention.

Production Techniques

The technological components of animal production that should be considered by research and development activities are listed in Table 1. Many of these should be evaluated at central or international research institutes, where expertise and institutional support could be provided for long-term technology development. Eventual improvements could be transferred to local production systems. These components listed as "passive" are not limiting at present production levels and would not become a serious limitation to production until other active constraints have first been removed. An example is animal breeding, which will generally not become a priority until more immediate limits on the food supply are first dealt with.

The production factors recommended for consideration at the local level; forages, on-farm by-product utilization, feeding systems, production economics, and credit and input support, are all dependent on farm type and environmental factors. Research on these aspects of animal production should follow a systems approach best conducted by an interdisciplinary team. This area-specific research approach would utilize results from centralized national and international research institutes and evaluate the potential application of these results to the production systems predominant in the area. The introduction of new forage or browse species on mixed farms, for example, although dependent on specific traits of the local production system, requires access by local researchers to genetic material with known productivity, nutritional quality, and disease and insect pest tolerance.

National and international centres can provide these new genetic materials from their pasture collection, breeding, and evaluation programs. Similarly, basic techniques for increasing the nutritive quality of agricultural by-products could best be developed at centralized institutions. The method of their application on the farm will, however, depend on the specific crop and animal enterprise and the harvesting, storage, and feeding methods that it employs. Animal breeding, disease and insect pest control, and the chemical and physiological aspects of animal nutrition are also research areas that could be addressed at central locations. Their interaction with the environment is limited in the case of livestock or is already sufficiently defined to allow ready extrapolation of research results (Winrock 1981).

A very high research priority — the development of efficient forage crop and by-products based on year-round feeding systems — requires research at the local level that involves a forage crop specialist, animal nutritionist, and economist. This activity should be supported at the national and international levels by plant selection and breeding programs for the development of superior pasture and forage species and by research on methods of by-product utilization and feed storage techniques.

A major attraction for orienting research toward improving the productivity of smallholder animal production is that these enterprises provide productive employment of farm families and other labour available in the rural areas that would otherwise only be based seasonally or not at all. However, the focus on technological change for animal enterprises of small farmers also has associated problems and challenges; typically, overall production levels of such farm households are low, the livestock enterprises are complementary but subsidiary to the crop enterprises, livestock enterprises that demand only limited but regular labour time may well be competitive to off-farm wage and cash-generating employment opportunities, and much of the livestock products are either used on the farm or for home consumption. The small size of farm enterprises and the subsidiary role of livestock production mean that even major technological breakthroughs for increased product per animal or number of animals produced per unit of land will have only modest effects on overall production for a typical farm household. If the new technologies require additional purchased factors of production, such as fertilizer or feed supplement and/or additional husbandry labour time, then prospective increases in net farm household cash income may be even more modest. If the research orientation on increasing animal production of smallholders is to be compatible with the socioeconomic structure of opportunities at the household level and serve rural development as well as agricultural development objectives then the research of forage crop specialists, animal nutritionists, and production economists has to be complemented by the research of other economists and social scientists on the institutional structure of opportunities for livelihood in the local economy.

The Farming Systems Research Approach

A major emphasis for animal production research in Asia, therefore, is on the ruminant production systems of small farms. These systems interact strongly with the crop enterprise. They typically include a few large animals (cattle, buffalo, goats, or sheep), and generally are augmented by a small number of

Table 1. Importance, location, and disciplinary demands for research on the major technological components of animal production in Asia

Technological component	Relative importance	Research location	Disciplinary demands
Feed supply			
Production of forages	High (active)	Local and central	Agronomy, animal nutrition, and plant breeding
Utilization of crop by-products (on-farm)	High (active)	Local and central	Animal nutrition, agricultural economics, and agronomy
Utilization of by-products (off-farm)	Medium (active)	Local and central	Animal nutrition agricultural economics
Feeding systems	High (active)	Local	Animal nutrition, animal husbandry, and agricultural economics
Animal breeding			
Resistance and increased production potential	Low (passive)	Central and international	Animal breeding
Crossbreeding of existing breeds	Medium (active)	Central and international	Animal breeding
Disease and pest control	Medium (active)	Central and international	Veterinary sciences, animal physiology and pathology
Processing of animal products	Medium (passive)	Central	Agricultural economics, food sciences, and animal husbandry
Grading and marketing	Medium (passive)	Local and central	Agricultural economics and food sciences
Animal nutrition	High (active)	Local and central	Animal nutrition and animal physiology
Economics			
Production economics	High (active)	Local and central	Agricultural economics
Policy, prices, and markets	Medium (active)	Central	Agricultural economics
Credit and input support	High (active)	Local and central	Agronomy, agricultural economics, and animal husbandry

scavenging nonruminant animals. Some of the animal products are consumed on the farm and some are sold, generally in small quantities, to local markets. For these reasons, they present unique challenges to the research and extension institutions and require a different approach to research.

Farming systems research methods were initially developed to study complex multiple cropping enterprises on small farms (Zandstra et al. 1981). Recent applications to the study of animal production systems have followed the same basic methodology (Winrock 1981):

- A substantial part of the research is conducted with farmers or on their farms.
- The objective of the research is an improved production recommendation for a defined set of environmental conditions.
- The research is conducted by a multidisciplinary team that is prepared to consider modifications in several crop or animal production enterprises of the farm.
- The research team identifies production constraints present in the existing system and considers these in the design and evaluation of alternatives.
- The research team considers between farm enterprises, regardless of whether they are of a biological or economic nature.
- The research team considers the multiplicity of objectives that the farm family seeks to satisfy with the production system it selects.

The framework for farming systems research and development consists of site selection, site description, design, testing, multilocation testing, and production program formulation (Fig. 1). Research activities and instruments have been developed for each of these phases in such a way that the type of research conducted at a site is a result of the farm environment that prevails (Shaner et al. 1981; Zandstra et al. 1981). A brief description of the specific activities in each of the research phases is included below.

- *Selection of the target areas:* One or more geographical areas representative of a large homogeneous production zone are selected. If possible, the area should be a priority area for development by the national government. In this way, when the potential for increased production has been demonstrated, support for production programs is more likely to be generated as long as the likely small producer beneficiaries of such programs are included among target beneficiaries in area development plans.
- *Site description:* The first activity is to describe the existing farming systems, the physical environment, constraints to production, socioeconomic environment, etc. The characteristics of the farm environment will decide research priorities at the on-farm research site and at supporting research stations. At this time, the area is also divided into different land types, each of which may require a different production recommendation.
- *Selection of land types or farming systems:* The stratification of the target area into land types is based on important environmental traits that are generally reflected in the type of crops grown on the farm and the type of animal feeding system or animal species that predominate on the farm. Because of staff and financial limitations and to reduce complexity, the research is generally confined to one or two land types and the predominant farm types associated with them.
- *Selected land types:* For the selected land types, the predominant farm types are studied in depth over time. This step occurs while other research is ongoing and continues throughout the testing phase. This analysis concentrates on the biological and economic performance of the existing systems and their components. In mixed farming systems, particular attention should be paid to the competition for farm resources (cash, labour, and land at certain times of the year) and to input transfers between subsystems (crops as feed, manure as fertilizer, animal power, etc.). The particular roles that livestock play in the farm enterprise should be clearly defined.
- *Design of alternative systems:* This activity includes the design of alternative cropping patterns, feeding systems, animal housing, and management methods that are well adapted to the area. The design of alternative production methods takes into consideration the physical and socioeconomic characteristics of the site, performance under existing production methods, and available component technology for the crops and animals in the farming system. There are numerous practices that must be specified at the design stage. Many can be specified on the basis of existing knowledge and local methods. Others warrant separate experiments to establish optimal input levels or handling methods. Component technology research may be conducted in national, regional, and local experiment stations or, where possible, in the farming systems research sites.
- *Testing of alternative systems:* This activity involves the testing of the designed systems and selected management components in their respective environments on the farm. Farmers participate in the testing by managing the crops and animals according to the designed methods, with frequent advice and constant monitoring of the research staff. Based on the biological and economic performance of designed systems, problems that limit intensification

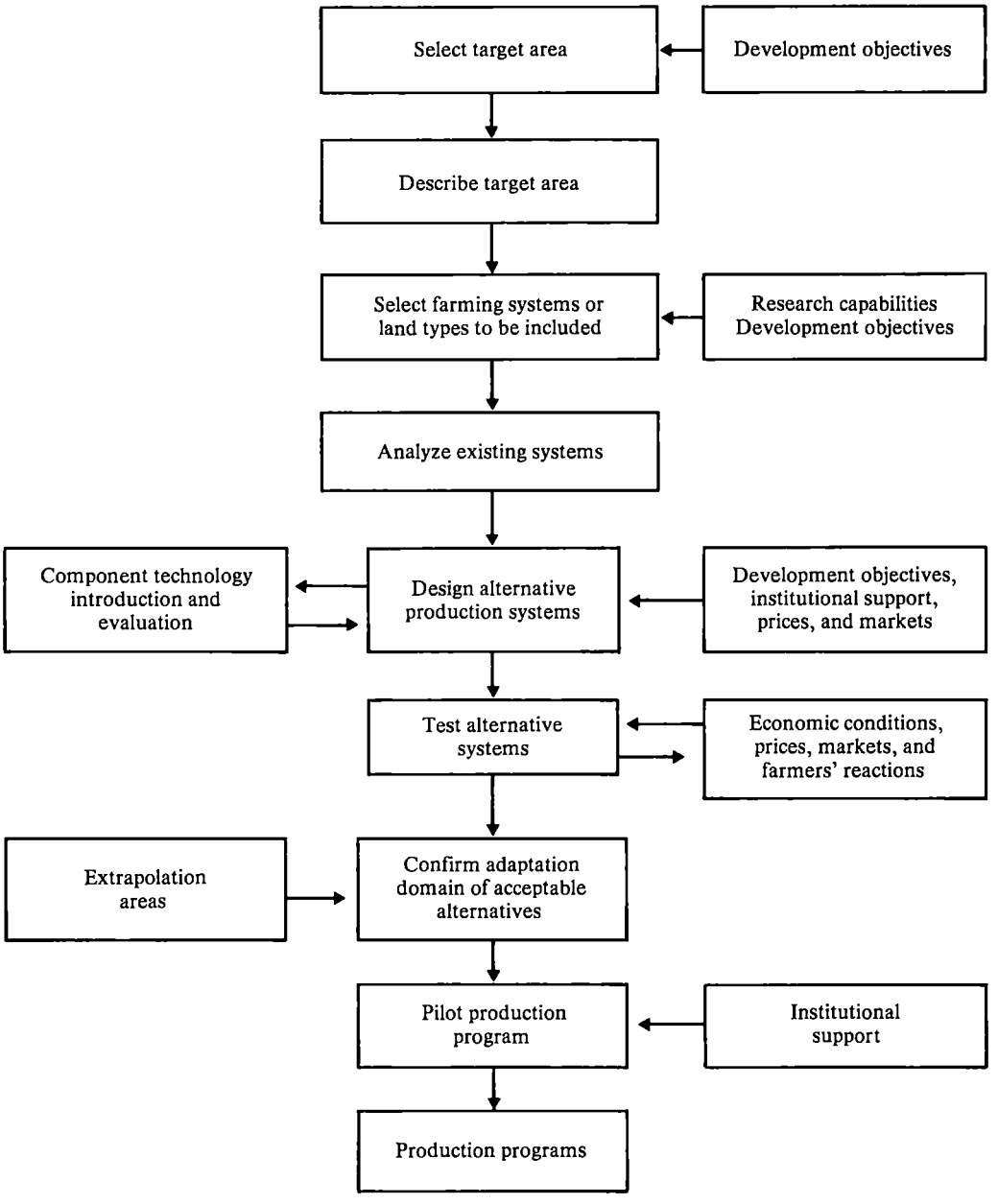

Fig. 1. Flow of activities in research and development of mixed farming systems.

of production can be identified and fed back to discipline- or commodity-oriented researchers. This scheme helps orient such research to solve relevant problems of the target farmers. The evaluation of alternative systems involves careful analyses of the performance of each component management change in terms of its contribution to farm productivity. Whole-farm analyses are used to evaluate the performance of a number of changes in the management components of the alternative system under

evaluation. Farmers' observations and their tendency to adopt changes in the study area are important means of evaluating alternatives.

- *Extrapolation areas:* When acceptable alternatives have been identified, greater benefits can be achieved by extrapolating the research results to a wider area. Identification of similar land types and confirmation of the suitability of the new production methods to those environmental homologues is a necessary step prior to extension activities.
- *Pilot production program:* On-farm testing and the identification of extrapolation areas have by this stage provided substantial information about the performance of the new production methods. A pilot production program is often advisable before embarking on a large-scale extension activity. Such a program generally starts off in the original testing area and has the objectives of identifying the institutional support and intervention required for the successful introduction of the recommendation. If successful, this experience will provide the information needed to design a full-fledged production program.

It is important to recognize that the various phases of a farming systems research approach described above are conceptual phases rather than temporal stages in the development of production programs. It is essential that at least preliminary research on the likely effects of possible pilot production programs reflecting various alternative systems that are regarded as possible recommendations derived from on-farm trials be undertaken simultaneously with the on-farm research. Analysis of market demand may be needed even before the formal decision to launch a program of livestock production using a farming systems research approach.

Economic and Institutional Aspects of Farming Systems Research

First and foremost is the need for increased participation of economists in on-farm production research. The inclusion of economists in agricultural research institutions and their participation in the development of improved production technology has been severely lacking. The description and analyses of existing production systems with the aim to understand existing constraints and interactions between the crop and the animal enterprise is an important area for contribution by economists. This analysis must consider the different products derived from production systems (power, cash, security, food, etc.) to identify the objectives that must be satisfied (or protected) by any alternative production method. In mixed-farm types, the simultaneous modification of the crop and animal production subsystems (e.g., introduction of a premonsoon legume crop that delays the rice by 20 days and, thus, reduces its yield by 15%) can lead to such complexities that ex ante evaluation of designed technology requires substantial capability and may need simple whole farm models (Borel et al. 1982).

Similar methodological difficulties arise at the technology testing phase (Fig. 1). The results of on-farm trials are evaluated by comparing the performance of the alternative technology to that existing on the farms. In the case of modifications to the animal production system, the analysis becomes very complex because of the multiple products and the difficulty of costing crop by-products, labour, and agricultural inputs. Where the new animal production technology also leads to changes in crop production, whole-farm analyses rather than partial budgeting may be required (Jayasuriya 1979b).

There is a need for the involvement of other economists and social scientists where there is differential access for various groups of rural peoples in the target area to land resources for farm enterprises or to new market and investment opportunities that might be generated by new livestock technologies. The farming systems research approach to livestock development of smallholders explained in the previous section is only sufficient if two presumptions do in fact hold: the predominant agricultural systems of small farms relate only to the land type and agroclimatic zone in which the farms are operated; and, if there are technology improvements for livestock enterprises that figure among prevailing farming systems then large numbers of these small farmers are both able and will, in time, adopt the improved livestock technology into their farming systems.

In Asia, although predominant farming systems are closely related to land type in most cases it must be noted that they also are related to other factors. The location of specialized monogastric production systems is more closely related to proximity and costs of transport to urban markets for products than to the land type in the area. Although ruminant production is now mostly derived from small mixed-farming enterprises, future technological developments may also encourage large-scale specialized production enterprises located according to market considerations rather than land type.

An important factor affecting existing farming systems practiced by smallholders and the willingness and ability of smallholders to adopt technological improvements is the distribution of land ownership and use rights and the costs and other constraints on land use under different tenure arrangements. Access to much of the irrigated and rainfed wetlands in Asia are controlled by tenancy

arrangements whereby the farm operators have to share some of their product with the land owners. Tenants may even be restricted or enjoined as to what enterprises they undertake on the farm. Where animal production is minor in relation to crop enterprises it is unusual for there to be a formalized agreement to share the animal products with the owner. Even landless labourers may be allowed under customary social practices to feed a few small ruminants or draft animals, used while employed by local farmers, on crop residues and graze on common pasture. Particularly in irrigated lowlands both population pressure and cropping systems development have already made small-scale livestock enterprises in mixed-farming systems less compatible with crop production. Rights to residual resources and feed are being asserted, and more owners are bargaining for the use of these factors.

In dry land and upland areas that are less accessible and subject to less population pressure, land tenure arrangements and practices that restrict or otherwise affect livestock enterprises of smallholders are less formalized or are not enforced. Much of the land is in the public domain and ownership rights, public or private, are difficult to assert. Land use practices and farming systems may well reflect the free good nature of the land to the user. This may well have led to overstocking and grazing of small ruminants on fragile soils and structures subjecting them to soil fertility loss and erosion. Such practices are particularly prevalent where land users expect to move on to other such lands once the fertility of land they are presently using becomes depleted. Where such fluid tenure arrangements prevail, the farming systems practiced, particularly the inclusion of small-scale livestock enterprises, may not be appropriate for the land type and area. Also, it is often difficult to predict whether small farmers will adopt technological improvements in the farming systems they practice. New technologies and new economic opportunities may lead to a reassertion of ownership rights and/or enforcement of share tenancy and lease clauses by owners, even displacement of squatters and tenants by large-scale commercial enterprises. Therefore, in site selection and description phases, and also in assessing the alternative system designs, there is a need for the economists and social scientists not only to assess existing production systems and economic feasibility of proposed improvements but also to determine who presently has access to land opportunities and who will be able to take advantage of new opportunities generated by the livestock technology developments.

In the design phase the research team requires a clear understanding of both factor and product market limitations. One of the most common errors in technology design has been to ignore the difficulties associated with satisfying the increased demands a new technology makes on the availability of agricultural chemicals, concentrate feeds, mineral salts, specialized equipment, and the production credit needed to purchase these inputs. The research of economists is needed to help analyze the economics of existing factor availabilities, and the work of both economists and other social scientists can help determine if and how institutional intervention should be used to increase the availability of these factor supplies.

Research prior to the commitment to pilot production programs on the price and income elasticities of demand for products whose production is expected to expand is needed to assure potential small farm producers that there is sufficient depth of market and long-run prospects for market expansion to warrant commitment of their resources to the enterprise. Almost as important may be studies to estimate price cross elasticities of demand for products that are substitutes or complements for animal products that are the targets in a farming systems development program. A reduction in market scope and resulting reduction in income for producers of substitute products has to be offset against gains derived by farmers adopting the new livestock technologies into their farming systems. Improvements in the marketing system and infrastructure to provide efficient channels for increased volumes of marketed livestock products are also needed, but without a comprehensive understanding of the complex system of consumer tastes and demand for different farm products it is difficult to select the product and varieties for development in a likewise complex farming system.

Economic Planning and Policies

Agricultural sector policies use changes in farmgate prices of products and agricultural inputs to stimulate food production selectively. There are two important areas where sectoral policies and technology development interact. The selection of research priorities and target areas and specific farming systems will depend on the perceived benefit from the research activity. On the other hand, regional development considerations may encourage governments to support research activities in needy areas. If this regional policy is not complemented by sectoral policies, production may not increase.

Many countries subsidize food grain, milk prices, credit, and input prices. Researchers employ domestic farm-level prices in the design and evaluation of technology. Depending on the responses obtained

by this technology, planners may be faced with uncomfortable consequences to the national treasury and unforeseen shifts in the production of certain commodities (the production of peppers in Sri Lanka in the mid-70s and the reduced planting of barley after rice in the Republic of Korea serve as examples).

Similarly, advances in production technology may lead to substantial shifts in resource allocation by farmers to various commodities. The double-rice cropping and rice–wheat sequence in India and Bangladesh have already led to a substantial reduction in the availability of grain legumes. Shifts induced by technology changes may require intervention by planners to avoid imbalances in the national food supply.

Conclusion

Small ruminant livestock production takes place mainly on small, mixed farms in Asia. Livestock production can best be increased by applying a farming systems research approach taking into account interactions between the crop and animal enterprises on the farm. It should emphasize the development of year-round feeding systems based on forage crops and by-products available at the village level. There is a major need for the participation of production economists along with animal scientists and forage specialists in the on-farm research at the local level to determine the economic viability of technological changes that are to be proposed for adoption into the farming system. Many of the areas where livestock production is an important element of farming systems in Asia are over populated in relation to the land resource base that provides a livelihood for most of the population. Access to this resource base and to investment market opportunities that are generated by improvement in the farming system are not equally distributed. It is important that there be socioeconomic analysis to determine which smallholder farmer beneficiaries and how many of them are likely to adopt livestock technologies that have been shown to be economically viable.

If livestock development is to proceed at a pace commensurate with the increase in population and demand for livestock products and services then there is no choice but to generate technological changes for livestock enterprises that smallholder farmers have incentives to adopt into their farming systems. The effectiveness of research to both improve smallholder livestock production in Asia and to improve the livelihood of rural households is greatly influenced by agricultural price policies, regional development programs, and national policies for the redistribution of access to natural resources and of sources of income. Close collaboration is needed between research groups and agricultural sectoral, regional, and national policymakers if livestock development programs are to meet their agricultural and rural development objectives.

Livestock and Feed Grain Models: Their Use and Drawbacks

Brian Paddock[1]

Abstract. Because decision-makers determine policies whether or not they possess adequate information, policy analysts must anticipate the issues in sufficient time to evaluate options. Models can help analysts to focus on issues to examine complex problems and to provide quantitative evaluations of policy options. It is, therefore, critical to select the appropriate model that will answer the question being posed. The assistance of commodity specialists in developing the model, can help ensure that the relevant technological and institutional constraints are reflected in the model. Care should be taken to ensure that the results are feasible, particularly if certain constraints are not incorporated in the model. Furthermore, results should be presented in terms of operative causal factors so that decision-makers are more sensitive to the way in which the various results actually come about. There is a tendency to expect reliable results in an unrealistically short period. Although there should be a continuing effort to improve the reliability of empirical models, operative models must also be maintained on an ongoing basis.

Résumé. Les décisionnaires déterminent leurs politiques sans toujours posséder l'information désirable ; c'est pourquoi les analystes se doivent de prévoir les sujets de décision bien à l'avance, afin d'évaluer les diverses options. Et pour qu'ils puissent concentrer leur attention sur les sujets importants, examiner des problèmes complexes et fournir des évaluations quantitatives sur des options de politique, les modèles peuvent leur être d'un grand secours. Il est donc crucial de choisir le bon modèle, celui qui répondra à la question posée. La participation des spécialistes des nourritures animales permettra d'établir un modèle qui tienne compte des contraintes techniques et institutionnelles. Il faudra également s'assurer de la faisabilité des résultats, notamment si certaines contraintes ne sont pas intégrées dans le modèle. De plus les résultats devraient être présentés parallèlement aux facteurs opérationnels qui les ont produits, de sorte que les décisionnaires soient mieux sensibilisés à la façon dont les divers résultats sont obtenus. Il existe une tendance à espérer des résultats fiables dans des périodes de temps beaucoup trop courtes. Bien que l'amélioration de fiabilité des modèles empiriques devrait faire l'objet d'une attention continue, les modèles opérationnels devraient être maintenus en état de fonctionnement ininterrompu.

In considering the usefulness of models for policy analysis and formulation, it is important to note that the motivation for changes in economic policy seldom results from economic analysis of potential alternatives. Rather, the policy agenda is largely beyond the control of the professional analyst and is mainly a product of the political process. The challenge presented to the economist (and analysts of other disciplines) is to provide decision-makers with timely information to enable them to make decisions that are optimal in terms of their set of political values.

But why should models contribute to better policy advice? Many government departments already include analysts who have a thorough knowledge of the structure of markets and usually have access to the data needed to address most policy issues. First, models force analysts to focus on issues in a rigorous way. They also assist in identifying which relationships are important.

Second, an increasingly large number of the policy issues extend across the specialties of commodity analysts. In fact many of the most important policy issues deal with the interactions between commodities or sectors. A university colleague once summed up general equilibrium economics as "everything influences everything else." He implied that the theory, although elegant, was of little operational value because it required a model that would be too large to be manageable. The preoccupation of agricultural economists with partial rather than general equilibrium analyses would support my colleague's con-

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clusion. However, the agricultural economics literature is increasingly addressing the linkages not only between subsections of agriculture but also those between agriculture and other sectors. The analysis of policies that simultaneously affect many sectors can be facilitated by a formal integration of expertise with a model.

Third, models provide quantitative answers. It may not, for example, be sufficient to predict that a higher support price of a commodity will lead to an increase in production or that a tax on the consumption will lower demand. The question posed by policymakers may be: "by how much?" Moreover, predicting the direction of change of a variable in response to a new policy may require a quantitative estimate, because theory may not be able to predict the direction of change. It is in the provision of quantitative answers that empirical models can expect to improve decision-making capability.

Designing the Model

In discussing the use of models one must begin by defining the scope of the investigation to be undertaken including identifying the problem that we are attempting to solve. What is the deficiency in the current or anticipated environment? This step is important because the questions will be important in determining the characteristics of the model that is required. For example, in analyzing the impact of changes in feed on livestock prices on the supply of meat and producer incomes, a neoclassical model such as Jarvis' (this volume) may be appropriate. Alternatively, for improving technical efficiency of producers, one might look to models that identify factors influencing the rate of adoption of new technology. The problem must be identified quickly so that the resources can be mobilized and the model developed to provide the information when it is required.

A second step in defining the scope of the investigation is to determine the choices to be evaluated. There is little point in investing heavily in a model to discover that a number of the choices favoured on political grounds cannot be analyzed because of the structure of the model. Communication is necessary between the policy analyst and those who are aware of the likely choices to be considered by decision-makers. The model must be designed to ensure, with reasonable probability, that all of the potential policy choices lie within the analytical capability of the model. However, policy analysts need not restrict themselves to analyzing solely those alternatives that are politically popular. Rather, the model's design should accommodate a range of policy choices that includes those that the political situation dictates must be examined.

Specifying the Model

The discussion of the specification of policy models will dwell upon general strategies or principles rather than detailed procedures. One immediate issue is whether the model is being designed to address a single issue and then set aside. This approach enables the development of a model that is a larger and more realistic representation of the sector or sectors involved. The maintenance requirements of such a model — keeping data and specifications up-to-date — might well overburden available resources. However, for certain issues where sufficient lead time is available, a model directed at a specific issue may not be feasible but necessary.

Alternatively one may choose to develop a more general model designed for ongoing use to address policy issues not yet on the agenda. However, this type of model may have a narrow focus in that it can only accommodate a small number of choices. Although it is possible to construct a model that could potentially address virtually all issues, even a general-purpose model will require modifications in some of its applications.

Where possible the model builder should work closely with the commodity specialists to have the benefit of their technical knowledge. The commodity specialist can advise the analyst as to the availability and reliability of data and how the data are constructed. This information is important because often the way in which data are constructed determines how they may be used appropriately.

Claims of data inadequacy should not prevent the development of models for policy analysis. The model should be specified before identifying data requirements. For example, modeling the dynamics of the livestock cycle requires knowledge of the marketing flows according to the sex of the animal to infer what decisions producers are making with respect to herd inventories. Increased collection and publication of such information is, in part, a response to model builders having identified these data as essential for improved analysis. Modelers can offset the lack of precise data by a creative use of alternative sources of information.

The commodity specialist can also provide information concerning institutional arrangements and government programs that influence the way in which the market responds to stimula. An understanding of how government programs influence

markets is particularly important in measuring behavioural responses. For example, what may at first appear to be a strong response to increased market prices may in fact be a response to government programs offering nonprice incentives to increase production. Without a knowledge of how these programs operate, one can end up with estimated relationships that are spurious correlations that will seriously impair any policy evaluation.

A second requirement in building a policy model is that the major constraints imposed upon the economic system be introduced quite explicitly in the model. For example, there is a certain gestation period for each type of livestock. Nature is insensitive to price incentives. However, this natural constraint may be less binding on the possibility for increasing the production of pork and is usually not binding for poultry. Similarly, at any given time there is likely to be a relatively fixed amount of land available for agricultural production. A model may be capable of replicating historical changes without recognizing these constraints explicitly. However, if the constraints are not explicit in the model, the results obtained from applying policy choices that severely shock the system will be misleading and unrealistic. For example, the model may predict that more heifers would be added to the herd than could exist, or that more hectares would be planted in crops than actually would be available for cultivation.

A robust theoretical framework is equally important on the demand side. Consumer demand of course, does depend upon relative prices. However, it is also a function of lifestyles, income, and other demographic factors. Thus, the demand structure itself may also be subject to change. In North America it used to be feasible to analyze the demand for red meats with little more than a passing reference to supplies and prices of fish, poultry, and eggs. The analyst who does so today is on very shaky ground. It is difficult if not impossible to account for all sources of changes in demand. However, a sound theoretical base will improve the reliability of the results. In this regard, recent application of duality theory provides a means of introducing more theoretical substance into models.

A final consideration in constructing a policy model is the source of coefficients to be included in the model. The reference here is to econometric models. It would be preferable if all of the required coefficients could be derived by applying regression techniques to the policy model itself. However, we need not be restricted to such an approach. Rapid changes in the economic environment may render coefficients derived from analysis of past data inappropriate for use in policy analysis. Moreover, the constraints placed on the structure of the policy model may make it impossible to always utilize theoretically appropriate structures. For example, it may not be possible to include the complete system of consumer demand equations implied by economic theory in a model designed to examine the demand for meat. However, it should be possible to transplant some of the relevant parameters, such as those presented by Cho (this volume), into the policy model. Similarly, if structural shifts make suspect coefficients based on past data, one might consider utilizing results obtained from cross-section studies or consumer surveys. The general approach is to view the policy model as a device for keeping track of a large number of complex relationships rather than as a means of measuring them.

Using the Model

By using the model, I refer to the process of analyzing alternatives and communicating the results to decision-makers. There are three points concerning the application of models to policy problems. First, one must attempt to ensure that the indirect impacts of policies are included in any evaluation. Many policy choices involve more than changes in prices and quantities. Consider, for example, a stabilization program that guarantees a minimum price to producers equal to the average price of a previous period plus an adjustment for changes in a selected set of costs. The impact of the program will differ according to producers' perceptions of the program: (a) payments may be seen as unpredictable windfall payments in which case no production response is likely; (b) payments may be seen as part of current income from the marketing of commodities, in which case producers will respond to price supports as if they were current price. If payments are made several months after the year is over, they may not be received until prices are actually rising and the program may seriously destabilize prices and production; (c) producers may anticipate support levels and plan production on the basis of the greater of the expected market or price support levels; and (d) producers may interpret the program as an implicit guarantee of "adequate" net returns. One might expect a substantial production response apart from that which might be attributed to any increase in price. In such instances, because we do not have certain information on how producers would react in such circumstances, a definitive analysis may be impossible, in which case policy impact must be analyzed according to different assumptions concerning producers' perceptions (Gardner 1981). Furthermore, the results should be checked carefully to ensure that an unexpected "quirk of the model" has not pro-

duced an unrealistic product. This point may seem trivial but may be disregarded where there is pressure for rapid responses. For example, although the biological constraints should be explicitly recognized in livestock models, the data are seldom available to achieve this aim completely. Therefore, in considering policy choices that result in sharp changes in production levels, it is important to ensure that the changes predicted by the model are actually possible. The end result may be correct but the biological constraints spread the adjustment over a longer period of time. However, the path of adjustment may be a critical part of the problem. Consider the situation of a planner who wishes to raise the support price for beef to increase production in anticipation of rising domestic demand. The planner could immediately increase the price sufficiently to motivate the desired long-run response. However, the process of increasing future supply involves diverting current production of female animals from consumption to breeding herd. In the short term, the decline in supply will raise beef prices. To minimize the effect on current prices, the planner may, therefore, decide to increase beef production more gradually by raising the support price in stages. In presenting policy analysis whose path of adjustment is unrealistic the credibility of the entire set of results would be called into question.

Finally, it is important that results are presented in such a way that decision-makers feel that they understand how the effects are felt throughout the system. First, an outline might be presented of the structure of the model and its major linkages, particularly as they relate to the policy choices being considered. Second, in discussing individual policy choices the impact analyses might be discussed in terms of the causal factors at work rather than simply as a set of final results. One way of doing this is through the use of impact multipliers or reduced form elasticities. These can give the decision-maker a "feel" for the relative magnitude of the forces at work in the market. It may also be possible to actually work through some alternative scenarios in front of the decision-maker if necessary rather than going back to the "black-box" for a new set of results. Not only does this save time, it also may improve how the results are received.

Managing the Model

The comments that I would like to raise with respect to model management pertain largely to models that are to be maintained for ongoing use. The impact of these models on policy has been less than that originally envisaged. One key reason for this failure is that initial expectations have often been too high. Their potential usefulness may not have been exaggerated but rather the cost in terms of time and resources to develop an operative model has been underestimated. Inevitably one particular sector or component of the model will fail to perform reliably. It is often necessary to respecify these sectors substantially and often more than once. In the meantime, the pressure for results mounts. Given the substantial investment of money and resources, repeated assurances that a usable model is just around the corner are viewed with increased skepticism. There is the risk that models will be allowed to die because budget-conscious decision-makers become unwilling to keep financing a project that appears increasingly less likely to yield the results that were expected of it.

Suppose one develops a model deemed capable of giving reliable answers at least to certain questions. It is then commonly assumed that the staff requirements for the modeling program can now be reduced. In fact, for some time, resource requirements are likely to increase. Responding to requests for analysis cuts heavily into the resources needed for further development and maintenance of the model. In particular, where certain components are known to be questionable, the results must be carefully monitored, and a number of runs may be necessary to obtain a set of results that is consistent and realistic. More work is required on unsatisfactory components of the model. If the resource requirements of the program are not provided during this interim period, the modeling effort may fail because staff will face a conflict between the time required to service requests and that needed to make the necessary modifications to the model.

The converse of the problem related above is that often the model builder's goal seems to be to build a perfect model. Consequently, the model builder continually tries out new specifications to improve its performance. Although this activity is desirable in principle, once a model is deemed capable of producing useful answers, it must be kept operational. The provision of timely and reliable responses to policy questions tends to reinforce the demand for such responses and, in turn, to reinforce the support for the modeling activities. Thus, it is critical that, once such responses are initially provided, the response capacity be maintained.

Another problem arises to some extent from the mystique in which models are held in some circles. Models can be of use in determining alternative means to achieve the decision-maker's goal. However, the decision-maker may also have in mind a particular alternative to this policy or certain criteria for assessing the acceptability of alternatives.

Models can also be useful in this regard. The difficulty arises when there is pressure to "tinker with the model" to give a particular answer. Such pressure is seldom explicit. In government service it may come through the knowledge that a minister or senior officials lean toward a particular type of program and would like a model-based analysis that would substantiate their position. At universities or other research institutions, the pressure might arise from knowing that the chances for future contracts or funds would be considerably enhanced if a particular result were obtained. Resisting such pressure is seldom easy. However, the modeler's credibility is jeopardized if this type of pressure is allowed to influence results. A more comprehensive peer review of research is one possible means of alleviating this problem. If the research results were to be published, the prospect of peer review might discourage researchers from bending to such pressures.

In conclusion, it should be noted that analysis, even if based on an excellent model and presented in a very effective fashion, will never be the sole basis for making a policy decision. The policymaker must take account of other considerations besides the economic ones. Economic analysts must accept this fact but try to put before the decision-makers the best possible set of answers to assist them in making policy choices.

Analytical Approaches to Farming Systems Research with an Emphasis on Animal Production

R. H. Bernsten[1]

Abstract. Farming systems research approaches have become increasingly popular in recent years. Yet, most programs focus on the crop component and overlook the livestock subsystem. Although there are several possible reasons for this emphasis, it seems that much of the methodology developed for crop analysis can be modified for livestock analysis. Several recommendations are made regarding the implementation of livestock systems research.

Résumé. Comment aborder la recherche sur les systèmes culturaux, voilà la question qu on se pose de plus en plus depuis ces dernières années. Et pourtant la plupart des programmes font une grande place aux cultures et laissent de côté la question du bétail. Cette différence de traitement peut avoir diverses causes, mais il semble que la plupart des méthodes mises en place pour l'étude des cultures pourraient, après quelques modifications, servir à l'analyse des questions de bétail. On trouvera ici plusieurs recommandations sur la mise en place de systèmes de recherche sur le bétail.

Over the past 5 years, farming systems approaches have become increasingly popular strategies for structuring agricultural research programs. In general, these efforts have focused on cropping systems and ignored livestock and mixed livestock/crop systems. Although numerous factors may explain this emphasis, there do not appear to be any major conceptual reasons why many of the methods used in cropping systems analysis could not be extended to livestock systems. However, to overcome some of the practical problems of conducting village-based animal trials, it will be necessary to experiment with various field techniques to identify workable approaches. After reviewing the major characteristics of farming systems research an attempt is made to draw upon the cropping systems experience to suggest how this methodology could be extended and utilized by livestock scientists.

Farming Systems Approach

Farming systems research (FSR) refers to research that views the farm in a holistic manner (TAC 1978). FSR programs can be divided into two types: upstream FSR programs that use experiment station results to develop prototype solutions for a large area, and downstream programs that use a "farm level research approach whereby farmers and a multidisciplinary research team work together to diagnose, design, modify and improve farming systems in a local area" (Norman 1980).

The farming systems research approach is evolving to fit the needs of developing-country agriculture. Norman (1980) has identified common themes that characterize most downstream farming systems research programs, including: (a) four successive research stages — descriptive (diagnostic), design, testing, and extension; (b) emphasis on farmers' involvement in improving the system, utilizing the best of the existing system plus productivity-increasing innovations; (c) the involvement of multidisciplinary research teams at all research stages; (d) recognition of the location specificity of research recommendations and the need to develop differential technologies for major ecological and socioeconomic milieus; (e) the need to understand the multiutilization of resources and the rural household as a production and consumption unit to guarantee that all relevant factors are considered; (f) the dynamic and interactive nature of the research process and the need for continued communication between farmer and research worker; and (g) the feedback provided by farming systems research for setting priorities in basic and commodity research programs.

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Yet, considerable differences exist between individual scientists in interpreting and actually applying such concepts as multidisciplinary, holistic, and farmer involvement. Consequently, at the operational level, even downstream programs differ considerably from each other.

Whether the downstream farming system approach is actually a new strategy or, as suggested by Johnson (1981), simply the rediscovery of 1920s–30s farm management techniques is irrelevant. The important point is that in most developing countries research has been commodity and experiment station focused. The farming systems approach will not solve all of the agricultural development constraints, but it should contribute toward focusing research on the problems actually facing farmers in these countries.

Livestock Systems Research Constraints

In practice, most downstream research is really cropping systems research because animal subsystems are not explicitly considered as a component. There are relatively few instances where a downstream farming or livestock systems approach, i.e., whole farm or animals plus associated crops, has been tried. There are several possible explanations:

- *Institutional affiliation*: The current interest in downstream cropping systems/farming systems research can be traced to the activities over the past 10–15 years of a few key individuals and institutions, especially the international agricultural research centres, regional centres, the International Development Research Centre (IDRC), and the Ford Foundation. These approaches resulted from frustrations experienced in trying to use conventional research techniques to develop new technology for small farmers in the Third World. Because of the importance of food grains in most developing countries, these individuals have worked in institutions with a crop focus. In several instances, the livestock sector was excluded because animal research was outside the institute's mandate.

- *Commodity-focused research*: In almost all instances, crops and livestock research are conducted by separate faculties or institutes. In neither case, does there exist the technical capacity to support joint crops and livestock research programs. These difficulties are often compounded by administrative and professional obstacles preventing separate institutes from developing joint crop–livestock research programs.

- *Production system focus*: Particularly in Latin America and East Africa, animal scientists and veterinarians have primarily been interested in cattle produced under extensive, pasture-based systems where there is little need to consider field cropping activities. Animals like water buffalo, sheep, goats, swine, and poultry, which are important to smallholders, have been neglected. In contrast to crop scientists, animal scientists until recently have not been as involved in the problem of increasing smallholder productivity. Consequently, they have not felt the same need to devise new research strategies paralleling the cropping systems methodology.

- *Research system priorities*: In most developing countries, crop research has been given higher priority than animal research. Furthermore, the international centres associated with crops are older, have developed strong collaborative research networks, and can easily transfer germ plasm between countries. Consequently, crop scientists have access to a much greater store of basic and applied results upon which adaptive field trials can be designed. Therefore, it has been easier for crop scientists than animal scientists to move toward emphasizing village experimentation.

- *Systems complexity*: Although it is relatively easy to conceptualize a whole farm model, it is much more difficult to collect data describing all of the subsystems. Even if all the relevant factors were present it would still be impractical to use a whole farm approach because integration of the volume of data needed to model a farming system requires access to a computer and a high level of training. In applied downstream FSR, these resources are seldom available.

- *Characteristics of the experimental unit*: Downstream farming systems researchers generally emphasize the importance of farmers' field experiments during the design and testing stages. The field techniques used in cropping systems research are relatively more difficult to apply to livestock systems analysis: (a) *Mobility* — Crops are planted, mature, and reproduce at a single site. On the other hand, animals, except under confinement systems, are mobile, making it extremely difficult to control and/or measure factors that are not varied as treatments (Fitzhugh 1982). (b) *Life cycle duration* — Annual grain crops typically mature in 3–4 months. By comparison, the reproductive cycle of ruminants (sheep, goats, water buffalo, and cattle) is considerably longer. The long period needed to evaluate a treatment makes animal trials more expensive to conduct than crop experiments. Mortality during the lengthy trial period reduces the original sample size consid-

erably and makes data analysis more difficult. The longer life cycle makes it difficult to incorporate quickly the results of the experiment into the next round of trials. (c) *Multiple outputs* — Crops generally produce a single major output, such as grain. Animals produce several outputs that have an economic value; for example, sheep produce meat, wool, manure, and lambs. Consequently, in evaluating a trial, it is usually necessary to assess the effect of a treatment on a number of outputs. (d) *Intermediate outputs* — Crops are generally produced for consumption. In contrast, animal outputs are often intermediate products that are used as an input in the crop or livestock system. For example, goats produce milk consumed by the young kids that are often sold as meat and manure is used for fuel or fertilizer. It is more difficult to evaluate a technology that also affects the production of intermediate outputs. (e) *Experimental unit size* — Individual plants are relatively small and can be easily manipulated in experiments and field trials. At a relatively low cost, a large population of plants can be included in a treatment. In contrast, animals are large, therefore, livestock experiments are expensive and difficult to administer. (f) *Producer attitudes* — Crop producers seldom develop an emotional relationship with their plants, but livestock producers may become attached to the animals. Also, religious taboos are often significant. These attitudes sometimes make it difficult to cull poor stock, castrate, and ear-tag animals. (g) *Adjustment factors* — To obtain the net effect of a treatment on an animal population, adjustments are often needed to account for differences in sex, age, breed, litter size, lactation length, and breeding interval. Because small-scale farmers usually have only a few animals, it is often difficult to conduct an experiment in which it is possible to adjust for all factors that animal scientists believe can affect experimental results.

The constraints noted may help to explain why there have been few downstream FSR projects. Most of these obstacles are institutional and could be overcome, once they are recognized and interest in seeking solutions has evolved. Constraints associated with the characteristics of the experimental unit primarily affect the way in which animal experiments are conducted and analyzed, not the applicability of the FSR approach itself. Animal scientists who have experienced frustration in transferring experiment station research results to village farmers would likely benefit from attempting to incorporate several concepts that have evolved through the cropping systems experiences. At the same time, these scientists could make a substantial contribution to the refinement of special methodologies required in the assessment of the livestock component of FSR.

Observations on the Cropping Systems Experience

Several detailed monographs have been written describing cropping systems activities throughout the world (TAC 1978; Gilbert et al. 1980; Norman 1980; McIntosh and Surjatna Effendi 1981; Shaner et al. 1981; Zandstra et al. 1981). This section focuses on issues that are particularly relevant to animal scientists interested in downstream FSR.

Research Planning

Research is aimed at obtaining the information to test specific hypotheses (Bernsten and Herdt 1981). The acquisition of new knowledge based on the scientific method should be guided by six basic steps (Venden Berg 1980): (a) defining the problem by observing the situation and reviewing relevant knowledge. Based on these activities, hypotheses are stated, questions are framed, and procedures or experiments are designed that are capable of rejecting the hypotheses (or answering the questions); (b) planning the research to collect the data required to evaluate the hypotheses or answer the questions; (c) carrying out the experiment to obtain the desired data; (d) analyzing the results so that conclusions can be drawn; (e) interpreting the results so that practical applications can be made; and (f) reporting the results in a way that all relevant audiences will benefit from the knowledge obtained.

Failure to identify hypotheses explicitly, to formulate the criteria for evaluating these hypotheses, and to specify data to test them before initiating research frequently results in the collection of a great volume of irrelevant data and failure to collect necessary data. In many Asian countries where cropping research is in progress, data overkill has been a significant problem. Because farming systems are complex there has been a temptation to try to evaluate all aspects of the system. The ability of computers to handle vast amounts of data could aggravate the problem.

In focusing the FSR program, it may be helpful to develop a model of technologies that seem relevant for increasing crop and livestock production Fig. 1. The branches represent various hypotheses with respect to primary production constraints and could help to guide the systematic planning of data collection and initial field trials. In other words, the initial research activities should focus primarily on assessing the status of the primary production factors to determine which are major constraints. Subsequent activities can focus on breaking these constraints with respect to both technical and socioeconomic phenomena.

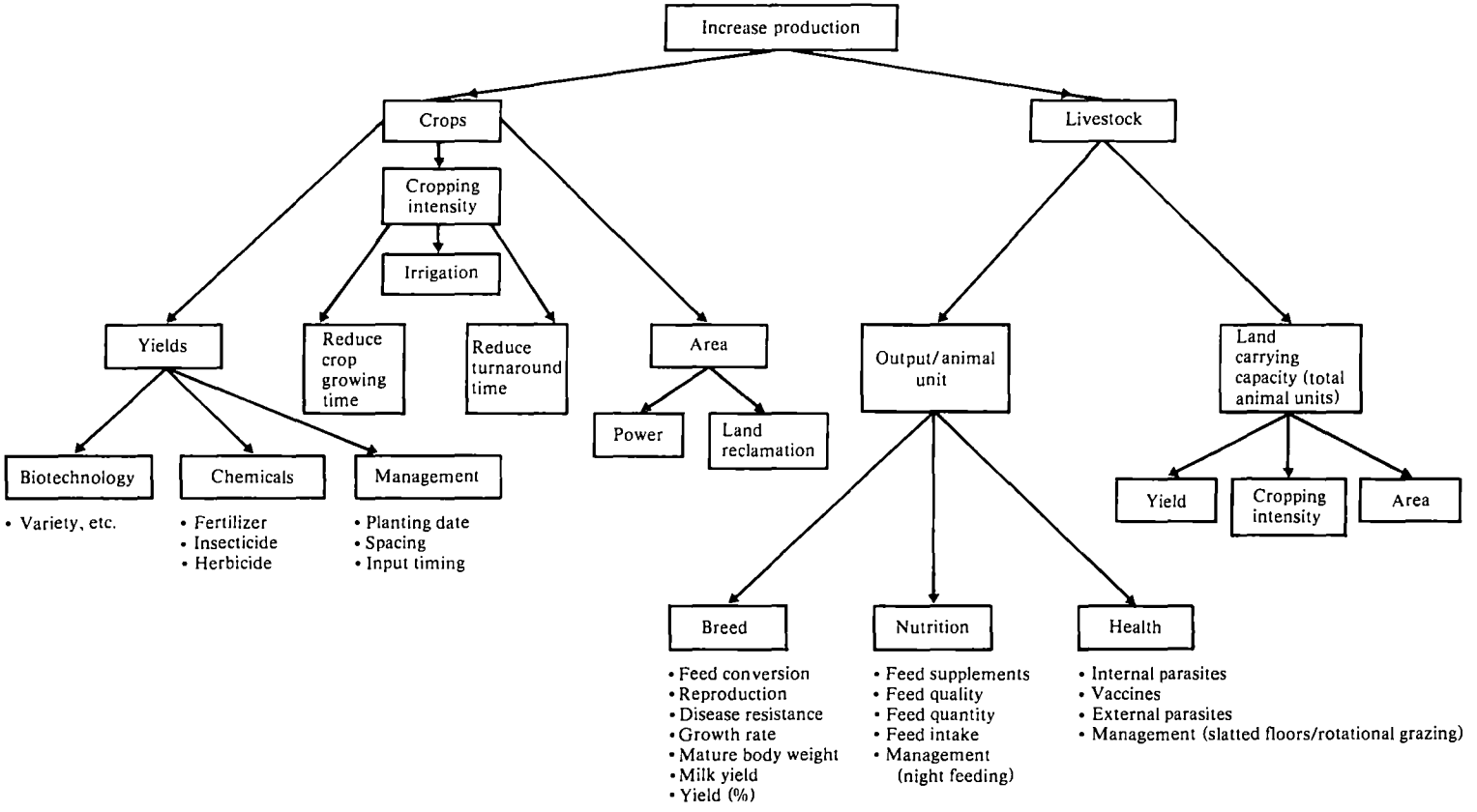

Fig. 1. Alternative technologies for increasing crop and livestock production.

Site Description

Baseline surveys have become a standard component in many agricultural development efforts. Advocates suggest these are a means for obtaining a comprehensive understanding of the farming systems, for generating baseline data against which project impact may be measured, and for identifying production constraints that should be tested in field trials. To achieve these objectives, the researcher must spend time at the site to become familiar with the situation before drafting the questionnaire. The questionnaire must be designed carefully and pretested before being finalized. Unbiased sampling frames are needed. Interviewers must be trained carefully so that questions are put and answers recorded accurately. Data must be tabulated rapidly and a report must be written to integrate the data into a meaningful whole. Because resources are seldom available to meet all the above requirements, the effort often falls short of achieving the initial objectives and drags out over months or even years during which the biological researchers proceed without benefit of the needed initial site assessment.

In Indonesia, a rapid rural appraisal strategy has been developed for crops as an alternative to the baseline survey. Once a target area has been identified, an agroeconomic profile is obtained of representative villages (Bernsten et al. 1980). The profile is based on a 1–2 day reconnaissance visit by three to five scientists representing several disciplines. A set of blank tables are used in place of a standardized questionnaire. The team meets with key informants (village officials, extension agents, etc.), conducts group interviews with selected farmers, and observes the farming environment. Information on various characteristics of the site is integrated into a composite agroeconomic picture of the village. In adopting this approach to meet the needs of animal scientists, particular attention must be paid to identifying interactions between systems components and constraints to increasing crop and livestock production as outlined in Fig. 1.

Information obtained from these procedures may be used to guide future research activities, such as:

- *Problem-focused surveys*: In some instances, it may be desirable to follow the agroeconomic profile with a problem-focused survey of a sample of farmers to investigate specific issues in greater depth.
- *Monitoring activities*: The agroeconomic profile can be used to assess the precision of data, especially where seasonal variation is expected. Information concerning fluctuations in the quantity and type of feed offered to confined animals, labour input, and weight gain can only be obtained by monitoring farmers' activities frequently.
- *Systems interactions*: The agroeconomic profile can also be used to identify interactions between various components of the farming system. The purpose is not to determine input/output coefficients, but to understand major interactions in the system. For example, if farmers use rice straw as a mulch to reduce soil erosion and preserve soil moisture, it may be unavailable to use as a livestock feed.
- *Farmer trials*: The agroeconomic profile can help identify farmers' technologies and levels of productivity. This assessment can then be used to design trials to be conducted on farmers' crops and animals.

The agroeconomic profile does not generate precise data for statistical analysis. Rather, it provides a description of the farming system, identifies farmers' problems, and is available immediately for use in planning subsequent research activities.

Similar rapid evaluation procedures have been developed by other researchers and used in applied farming system programs to describe the local farming system and plan research (Mathema and Van Der Veen 1978; Byerlee et al. 1979; Collinson 1979; Hildebrand 1979; Chambers 1981).

Design

Information from site description activities will suggest possible interventions that potentially may increase production and incomes. The availability of resources and scope of the research program will determine the diversity and complexity of trials. Ideally, crop and livestock scientists should work together at a farming systems site. Yet, this may be difficult in most countries. Consequently, livestock scientists focus on design components affecting the animal and the feed base.

The descriptive phase of the research project frequently extends over a year or more. The descriptive, design, and testing phases should not be seen as sequential with respect to the whole research program, but iterative and overlapping. For example, it may be possible to design a parasite control scheme and begin testing it immediately after completing an agroeconomic profile. On the other hand, a feeding intervention may require monitoring of existing feeding practices to design a potentially feasible technology. Agroeconomic profiles, surveys, and the monitoring of farmer practices only describe the existing system. To improve it, the research program must move rapidly from description to designing and carrying out farmer trials that can assess potentially productive new technologies.

Descriptive data can be used to identify research that is likely to yield a high return. In the following hypothetical example, data associated with sheep offtake are obtained from an agroeconomic profile: days from weaning to heat (15), conception rate (1.5

matings), gestation period (150 days), birth to weaning (105 days), and weaning to 20-kg sale weight (365 days). The data show that the time from weaning to sale weight is extremely long, a problem upon which research should be focused. Slow growth may be the product of such factors as internal parasites, mineral deficiencies, low feed intake, or low growth potential. In another hypothetical case the following data are obtained concerning lamb survival rates: live births (95%), average litter size (2.4), lambs surviving weaning (66%), and animals surviving to market age (95%). These data show that about all parameters are reasonably high, except for the percentage of animals surviving weaning. Research should focus on the cause of such high losses. The above approach would identify the life stage upon which research should be focused, but the specific trials would be implemented on the farm.

Livestock recommendations from the experimental station or extension service can also be tested at the farm level because they represent the conventional wisdom as to appropriate technologies (Patel et al. 1978; Branon et al. 1979). Field testing will evaluate their applicability under farmers' conditions. Possible treatments that could be imposed on farmers' practices to evaluate biological response are applicable to animal health (endo- and ectoparasite control, vaccinations), animal nutrition (commercial, mineral, improved forage, and new by-product supplements), and breeding (remove major health and nutritional constraints to evaluate genetic potential). Once a response is identified, future trials could include multiple treatment levels to identify optimum combinations.

The difficulty in attempting to conduct single- and multiple-factor animal trials at the farm level is directly related to the type of production system and animal involved. Generally, the more confined the system (from fully confined to tethered, fenced, grazed, and free), and the shorter the reproductive cycle of the animal (from poultry to pigs, sheep, and cattle), the easier it will be to conduct the trial with the control and replications desirable in experimental station trials. If animals are not paired as comparable experimental units and the trial is replicated several times it may be difficult to detect small but significant differences in treatments. However, if the anticipated effects are so small as to require the complete control of extraneous factors, the technology would probably never be adopted by farmers because they would not be able to visualize its benefits under their own production conditions.

Strategies for increasing feed (forage legumes, grasses, and crop residues) could be tested in farmers' fields in the same way as food crop technology is evaluated in cropping systems trials. Superimposed trials to initially screen potential technologies and multifactor treatments to identify optimum treatments might focus on factors that could increase yield (variety screening, fertilizer application, and management practices), cropping intensity (intercropping with food crops and after harvesting food crops), and area (planting in fallow fields, on rice bunds, and along roadways). In many instances forages are not grown in contiguous parcels but alongside roads, on rice bunds, and on public land. These areas should be utilized as trial sites, because they constitute the actual conditions under which the forage must ultimately grow.

When to test packages of improved technology depends on the researchers' assessment of multiple-factor packages that are appropriate under farmers' conditions. It is advisable to focus on superimposed and multifactor component trials, especially for forage evaluation, and subsequently to use these results to develop complementary recommendations for testing under farmers' conditions.

Data Evaluation

As is the case with data generated in cropping systems research, it is possible to conduct sophisticated analysis of the data. Yet, highest priority should first be placed on developing straightforward standardized procedures. Most of the experimental data from farmers' field trials can be analyzed rapidly using a programmable calculator (Bernsten 1980). In addition, programs for economic analysis will facilitate standardized evaluation and reporting of research results. These have been successfully used by the Mennonite Central Committee cropping systems projects in Bangladesh to evaluate cropping patterns.

In cropping systems analysis, a great deal of emphasis has been placed on the economic evaluation of cropping patterns trials, but relatively little attention has been given to the economic analysis of component and multifactor trials. As animal scientists become more involved in field activities, a great deal of experimental data will be generated. Trial results should be subjected to simple but rigorous analysis to evaluate its profitability and applicability for adoption by farmers. Cost/benefit procedures, developed by the Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT) economists are a particularly useful starting point (Perin et al. 1976). The analysis should also incorporate discounting procedures to account for the long payback period to a livestock investment.

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Discussion Summary

A. John De Boer

Papers in this session represented a final stage in the continuum covering livestock research in Asia. Several of the topics provided detailed approaches indicating how biological and economic research could be integrated at the farm/village level. All approaches focused on data requirements, practical aspects of putting together integrated research programs of real benefit to small farmers, and the requirements for hypothesis testing to sort out the critical constraints under which the farmer operates. In addition, the point was emphasized that there are often unexpected consequences of programs designed for technical change. These are particularly difficult to capture by formal modeling approaches and to accurately predict some of these changes requires a combination of research experience and knowledge of the farmers' perceptions of change. In particular, livestock programs can often cause major shifts in values assigned to property rights in marketing conditions.

Three basic approaches were discussed. First, the formal mathematical modeling approach for the biological component of a cattle model was used to illustrate how the transition from models, developed under temperate conditions of good feeding/management, could be adjusted to account for conditions typical of much of the tropics.

Second, three papers focused on overall research methodologies that could be applied to research on animal production systems on mixed farms in Asia. One paper reported on an ongoing research project with a specific commodity — farming system orientation. Two others used the farming systems approach as a reference point and discussed how this approach could be applied specifically to animal components and to particular cropping systems. The key point was that this approach represents a philosophy and a framework under which research can be conducted rather than a set of concrete, sequential procedures to be applied mechanically.

This observation implies that considerable skill and experience is required of the researcher or research team. The discussions on farming system research identified four critical points relevant to the use of this approach in Asia: (a) the numerous roles played by livestock for Asian smallholders, (b) the fact that most ruminant livestock in Asia are kept by small farmers, (c) the agricultural systems under which livestock are produced in Asia are closely related to land types, and (d) the critical limits on each livestock system are the feed constraints imposed by the land types.

Finally, one paper had quite a different approach that fitted in well with the earlier papers dealing with the role of models in the agricultural policy setting. The practical considerations associated with developing, using, and communicating results from these models were all considered relevant.

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